BIOLOGY OF SENESCENCE

PROBLEMS AND PERSPECTIVES

RUDRENDRA KUMAR PAL

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BIOLOGY OF SENESCENCE:

PROBLEMS AND PERSPECTIVES

By

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PREFACE

OLD age is a bugbear to everybody and the very thought that one would be, some day, old with bodily disfigurement, lack of physical fitness and mental deterioration, is appalling. From time immemorial it has been the endeavour of the human race to find effective means or remedies to prevent such ills from happening. Search for "Elixir of Life", *kāyakalpa*, *prāṇāyām* and other yogic methods, Steinach's and Voronoff's rejuvenating operations and lastly the so-called wonder drug (?), the "youth pill" are some of the attempts made from time to time, to conquer old age and to prolong youth and indeed life-span itself. Before the last decade the idea of a trip to the moon was nothing but a wild goose chase ; but the astounding progress in scientific knowledge and technology within the last few years has made it a reality. So it may be hoped that some day in future, near or distant, indomitable human ingenuity and persevering efforts will also be able to formulate a method or discover successfully one or more remedies to prevent or defer the onset of old age with its consequent handicaps and prolong the life-span to a great extent. In the face of the inevitability of death, even this much, if achieved, is sure to be counted as a great feat.

In presenting this monograph the author does not claim any originality but frankly confesses that he has only tried to compile and summarize the existing knowledge on the 'Biology of Senescence' and point out its problems and perspectives in the light of recent researches.

About a year or so back my friend Sri S. M. Banerjee, himself a versatile reputed Bengali writer, requested me to write a book on 'How to conquer old age' and this small monograph is the result of my humble efforts in deference to his wishes. So I am thankful to him. I am also greatly indebted to another friend of mine, Dr. B. Mukherjee, who not only went through the manuscript in its formative stage but also suggested the very apt and fascinating title of the book. I cannot but acknowledge with gratitude my indebtedness to the Journals of Sandoz Ltd., and other foreign medical concerns for permission to reproduce some illustrations.

Lastly, I shall be failing in my duty if I do not thank adequately The Asiatic Society for publishing this monograph, but for whose assistance and courtesy the same would not have seen the light of the day. I am also thankful to Sri Biram Mukherjea of the Publication section for taking keen interest in the production as well as in scrupulous examination of proofs of this book.

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R. K. PAL

DEDICATED

to

The Cherished Memory

of

The Grand Old Man,

My most respected and beloved Grandfather

Radha Govinda Pal

whom

I Lost Forty-one years ago.

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INTRODUCTION

EACH and every living body has a limited natural span of life. The Biblical idea is that human life's span is only three score and ten years but according to the *Vedas*,[1] "Man is of a hundred (years) of age" and the popular belief in India is that a man and an elephant may live up to 120 years. So it is no wonder that Mahatma Gandhi expressed his desire that he would attain the highest possible limit of old age. The old naturalist school conceived that the duration of a mature life might represent a definite multiple of the period of growth. According to some, this multiple is 6 to 7 but others think that it is only 5, so that the mean duration is anything between 5 to 7 times the time required for the completion of growth. Be that as it may, it may be taken for granted that when one advances in years and finally steps into mature old age, death preceded by senile decay is the most natural and inevitable event. So Shakespeare[2] while describing the seven stages of human life, says

"The sixth stage
Shifts into the lean and slipper'd pantaloon,
With spectacles on nose and pouch on side,
His youthful hose, well sav'd a world too wide
For his shrunk shank; and his big manly voice
Turning again toward childish treble, pipes
And whistles in his sound. Last scene of all,
That ends this strange eventful history,
Is second childishness and mere oblivion,
Sans teeth, sans eyes, sans taste, sans everything."

Similarly Śhankarāchāryya,[3] the great Hindu savant and reformer also described the characteristic bodily features of a very old man as follows,

"अङ्गं गलितं पलितं मुण्डं दन्त-विहीनं जातं तुण्डं
करधृत-कम्पित-शोभित-दण्डम्"

that is, "the body decays and the head is hoary, with teeth all fallen out from mouth and furnished with a supporting stick in shaky hands".

In fact every one in extreme old age is nothing but a pitiable caricature of himself of the bygone days when he was in the full bloom of youth. What with infirmity and what with physical disfigurement he becomes an object of pity and derision to most of the younger folk, to whom he is nothing but an old fool who should be somehow tolerated. People from time

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[1] *Taittirīya Saṃhitā* (Black *Yajurveda*)—Parva 2. Kānda 7, 5.9.(2).

[2] Shakespeare, W., *As You Like It*, Scene VII, Act II.

[3] Śhankarāchāryya, *Mohamudgaram*.

immemorial are always afraid of such a pitiable and wretched condition of senile decay and incapacity. In the great epic, the *Mahābhārata*, there is an interesting anecdote relating to how the old king Jajāti exchanged his senescence for the youth of his son, Puru and after fully enjoying this borrowed youth for one thousand years, voluntarily returned it to the lender, bestowing on him not only best paternal blessings but also his kingdom, although the son happened to be the youngest one, in preference to four other older ones, as a reward for his extra-ordinary sacrifice to please his father.

According to Hoff and Ringel,[4] "respect for age, a dominant feature of life in the last century, is dwindling rapidly and giving way to an attitude of indifference and often hostility". This incompatibility or rather conflict between the younger and older generations very often causes the latter to overtax their resources without paying any heed to the psychosomatic danger signals, which is no doubt responsible for the final breakdown with undue suddenness.

A man growing old with dread of impending retirement from service or vocation in which he was engaged so long, all of a sudden, finds that he is not only weak in body and mind but also failing in internal strength to cope with or adjust himself to the changing situation. At this critical period he is required to muster all his strength to fill up the vacuum in the field of his activity by seeking 'fresh fields and pastures new', which alone can rejuvenate his shattered nerves. The more the degree of adaptation to this changed phase of life, the more he can find scope for new enjoyments for his life and thereby prolong his span by some years at least, with better health and sound mind, and avoid the dismal consequence of what Jores and Puchta,[5] so aptly termed 'retirement death'.

In fact old age is one of the most critical periods of a man's life, when for him there is practically no silver lining in the cloud and like the Prince of Denmark in extreme mental agony, the only question that is uppermost in his mind is 'To be or not to be'. Homoeostasis, according to Cannon[6] is the power of the body to maintain stability in varying internal environments. In old age this becomes more and more difficult to achieve, with the result that as age advances the ability to adapt or to adjust to various unfamiliar and changed circumstances of life, is gradually lost. Failure to adapt results in dissatisfaction, bitterness, pessimism, depression, weariness of life and sometimes to helpless resignation to fate or even suicide. Some, in order to get rid of the 'slings and arrows of the outrageous fortune' on mind take to addicting drugs like alcohol, opium, cannabis indica, etc., which hasten the inevitable exit from the world. All these were too true in the case of majority of the old people of the past generations up to the

[4] Hoff, H. and Ringel, E., *Triangle*, 1968, 8, No. 8, 317.

[5] Jores, A. and Puchta, H. G., *Med. Clin*, 1959, 54, 239.

[6] Cannon, W. B., *Lancet*, 1930, 1, 1109.

period of the great World War II. Since then, however, notwithstanding immense stress and strain on everybody's life due to advent of drastic political, social and economic tensions, the life span of people all over the world has definitely increased, thanks to the discovery of many life-saving drugs, such as penicillin, streptomycin, chloro-mycetin, terramycin, sulfa group of antibiotics, etc., better knowledge of hygiene and nutrition and improved techniques in surgical and medical treatment. The average longevity, even in our country consequently has shot up from 26 to 47 years within the last three decades.

In 1949 the Royal Commission on population in Great Britain published a report in which we find that the population aged 65 years in that country was one million in 1945 and with the prevailing mortality rate it was assumed that by 1977 the population of the old age group would rise to 7.3 millions. Besides this, the number of very old people above a century or near about that has also gone up considerably due to the use of life-saving drugs and better care of health.

In 1956 in Sweden, a country of nearly 7 million inhabitants only, about 10 per cent of the population was above the official retiring age of 67 and since then this percentage has been gradually increasing from year to year.

The Soviet Union of today is called the "country of longevity". Citizens over 100 years old are more than 21,000 or 10 in every 100,000 as against 1.5 in every 100,000 in U.S.A., 0.6 in Great Britain, 0.7 in France and 0.1 in Japan. In a recent census report of the U.S.S.R. a very interesting fact has been brought out about the population of the constituent state of Azerbaijan where per hundred thousand people more than 84 are centenarians and even octogenerians number more than fifty thousands. The oldest amongst the living is one Shirali Muslimov who is at present more than 150 years old. Next to him in age is Shirin Gassanov —a strict teetotaller, who is living happily with his third wife aged 80 years. Another one is Majid Agayev, 132 years old. In other states too such instances are not rare. One Demyan Chepak, a Byelorussian farmer is more than 115 years old (Fig. 1). Another Balakishi Aruzevi by name, aged 130 and his wife Amina who is 114 have just celebrated the hundredth anniversary of their marriage, which is so rare an event. Even some women much older than Amina are also found. Gosa Makneva, a woman collective farmer of Chillata, a village in Georgia is near about 150 years old while there are two other women of almost the same age in the village of Kurganskoyke of Krasnodar territory. It is also reported that many of the members of the Caucassian Choir are over 100 years of age (Fig. 2) and inspite of their ripe old age they are all perfectly healthy and hope to live active healthy lives for many more years.

The most outstanding longevity record in modern time is that of Tebza Abzieva, an inhabitant of Osetia (Northern Caucasus) who died a few years ago at the age of 180. Her nearest competetor is an Abyssinian of

Fig. 1. Demyan Chepak, a Byelorussian farmer is more than 115 years old.

Fig. 2. Members of the Caucassian Choir, many of whom are over 100 years old.

Addis Ababa, Abu Bakar Omar Adam by name, aged 174 years, who is still going strong and per chance may beat the preceding record.

Mention may be made in this connection of Lord Bertrand Russel, a great intellectual stalwart of the world, who married for the third time when he was 84, and was very active in body and mind even at 95 but was just unlucky not to hit a glorious century being short of only three years' run. In India too, Krishnadas Kaviraj, Jagannath Tarkapanchanan and quite recently Dr. Karve and Dr. Visweswaraya, each scored the rare but covetable century before they were out.* Victor Hugo on his 80th birthday said "I should like to go on for another eighty years". Two world famous physiologists were also of similar opinion and while Pavlov said "It ought to be normal for man to live to the age of 100", Tarkhenov wrote, "The time will come when it will be a disgrace for a man to die less than 100 years". Even Mahatma Gandhi, the Father of the Indian Nation with his frail body expressed an optimistic desire that he would live up to 120 years to serve his country and people. This pious hope might have materialized substantially had not the fanatic assasin's hand taken his life when he was short of 80 by a year only. The famous American Scientist and inventor Edison, at his 84th year expressed a desire to live for another 15 years to complete whatever was left to be done and when he was asked about retirement he smilingly answered, "that would happen only on the day before the funeral". Bernard Shaw also said some thing in the same strain thus: "When I die I want to be thoroughly used up. The harder I work, the more I live. Life is no 'brief candle' for me. It is a sort of splendid torch which I have got hold of for the moment. I want to make it burn as brightly as possible before handing it on to future generations."

It may not be out of place if I mention the instances of my long-lived grandfather who died when he was near about ninety and my father who expired at his ninety-sixth year with full mental vigour.

These are some of the instances which show that it is not at all impossible to live up to or beyond hundred years. But the question is, how one can protect oneself against the ravages of old age and senescence, to which the frail human body is usually and naturally a victim. Men from time immemorial, may be from the very dawn of his appearance on earth, left no stones unturned to acquire the 'elixir of life' to become immortal but even with tremendous improvement in his knowledge and achievements in science and technology, the discovery of this well-coveted elixir of life has baffled all human efforts and has always receded like the horizon before the eyes. In Hindu mythology there are accounts of repeated attempts of attaining immortality by different manoeuvres, fair or foul. Once, the story goes, gods deputed Kach, the son of Vrihaspati, their *guru*, to go

*Names mentioned here are some of the top ranking men of India but in some of the villages are still to be found some centenarians in good health. News papers' report says that quite recently on the 10th of January, 1971, the sub-divisional officer of Bongaon accorded a reception to two villagers of Chaygharia, a male Nakul Rishi and a female Hadari Dasi by name, aged 109 and 104 respectively.

to Shukra, the religious preceptor of the *asuras*, as his disciple and learn the *mantra* for resuscitating the dead, by dint of which the *asuras*, victims of death in warfare between gods and themselves, were always resuscitated by their *guru*, while the gods once so dead were dead for ever. And once again, there was a combined effort on the part of gods and demons to recover nectar by churning the sea for which they used the Mandar mountain and the serpent Vasuki as the churning rod and rope respectively for the act of churning, as a result of which nectar, the elixir of life was separated and it floated up. The gods were shrewd and clever enough to misappropriate this nectar for themselves by depriving the other group of partners in the laborious toil, partook of it and became immortal. That is indeed, a fascinating mythological story but the civilized man of today is yet to achieve this goal. Still persevering efforts of indomitable human spirit are not altogether failures. Within the last 30 years or so man has been lucky enough to find out some drugs—the 'antibiotics' with which it has been definitely possible to overcome fatal diseases so as to prolong the life-span and also the tranquilizers with which to suppress the mental worries and anxieties. Human intelligence and experience have also provided clues to check the rapid progress of decadence and senility to keep the health of the body and mind and hence their activity too, unhampered for a much longer period, with the result that the performance of their body and mind, even in advancing years is now much better than those of their forbears of the same age levels in the past.

If however, one is to prolong one's life-span and postpone an early or untimely onset of senile changes in the body, one must needs understand thoroughly the physiological deviations and structural changes in the tissues, pathological abnormalities and psychological alterations, to counteract them successfully by preventive measures with intelligence and perseverance, and thus certainly it is possible in at least 50-60 p.c. of cases to defer the ravages of old age, to possess an actively healthy body and a sound mind, and to enjoy a good old age, may be up to a century or near about it.

So in this monograph it will be my endeavour to describe in different chapters the special physiology of the old age, the structural changes in the different tissues, psychology and psychosis of the elderly, the common diseases of the old age, old age and mental activity, all in the light of recent researches and lastly how to achieve the well-coveted longevity with flush of health and soundness of mind. In this connection we must always remember and act according to the following oft-quoted lines of Longfellow,[7]

> "Trust no future, however pleasant,
> Let the dead past bury its dead,
> Act, act in the living present,
> Heart within and God o'er head."

[7] Longfellow, H. W., Psalm of Life.

CHAPTER 1

PHYSIOLOGY OF OLD AGE

DURING advancing years changes take place slowly and gradually in the composition and function of the tissues, which at first are scarcely noticeable but become more obvious as old age advances. Usually after 40 years the eye sight declines, the faculty of hearing diminishes, the muscular power deteriorates with loss in weight—may be up to 30 p.c., the number of nerve fibres in a nerve trunk drops by about 25 p.c., that of nephrons in the kidneys also falls to nearly half and the weight of the brain also decreases.

Circulatory System: The force of the heart is diminished so that it pumps less blood with each beat. The mean rate of heart beats and hence of pulse of the age group 60-65 is 80 per minute but thereafter there is a gradual decrease in the heart as well as pulse rate so that in an octogenerian it comes down to 65 per minute or near about. With growing old age the arterial wall loses elasticity and has a tendency to become more and more rigid. So a steady but not steep rise in blood pressure from adolescence to the age of about 60, is the rule in health and at 60, averages are 140 mm. of Hg. systolic and 87 mm. of Hg. diastolic. There after as the heart rate slows down the systolic pressure goes down further, although the pulse pressure ranges from 40 to 45 mm. of Hg. In women until menopause the systolic pressure is usually 4-5 mm. Hg. pressure less than in men of the same age, but with the onset of the climacteric there is some what abruptly a rise in the pressure which always thereafter remains a little higher than the male average of the corresponding age.

Blood: There is a tendency towards a minor degree of anæmia due to less number of RBC in blood and less amount of hæmoglobin formation. The resistance of the body to infections, poisoning etc. is less owing to diminished leucocytosis and less amount of γ-globulin in blood. Blood urea and serum cholesterol have a tendency to rise with increasing age.

Respiratory System: Respiratory movements are usually increased and laboured even on slight exertion. In many old persons tracheobronchial and pulmonary epithelia are hypersensitive to infections, especially during the winter months.

Digestive System: The digestive power is usually below par due to less amount of secretion of the digestive enzymes. As a rule the tone and normal contraction of the gastro-intestinal tract are less and so there is stasis in the bowels resulting in habitual constipation. Lack of tone and power of the muscles of the lower bowels is apt to stand on the way of complete evacuation of the bowels in answer to the call of nature, for which

repeated attempts may be required. Iron deficiency not only leads to anæmia but also may cause achlorhydria in elderly people. Very often old persons who live alone suffer from 'Bachelor's scurvy' due to vitamin-deficient diet with large bruises, bleeding gums and Royston's sign (curled up hair as dark spots on the forearm).

Metabolism: In old age metabolism of the living matter of the body becomes less and less perfect. Endogenous protein metabolism is as a rule, increased with more wear and tear of the body than can be replenished and so the body weight is diminished with more urea in the blood and excess of urea and phosphates in the urine. Ultimately functions of the protoplasm of the cells become more limited and may fail entirely causing what is known as death. The lipid metabolism too may be affected with increased amount of cholesterol in blood resulting in arteriosclerosis and hypertension. The utilization of glucose by the muscle is also hampered so that muscles are incapable of functioning efficiently. The mean heat output of the body also diminishes in old age.

Excretory System: Due to less number of nephrons the formation of urine by the kidneys is somewhat less, except in the case of small contracted kidneys. Frequency of micturition, especially at night, may be due to hypersensitiveness of the urinary bladder or prostatic enlargement in the case of males. There may be occasionally incontinence of urine owing to lack of control on the sphincter of the hypersensitive bladder, sometimes caused by unnatural constituents of the urine.

Muscular System: Due to loss of weight the efficiency of the skeletal muscles gradually diminishes after 45. That is the reason why sportsmen and athlets voluntarily and men in the active military service compulsorily retire when they are near about or actually attain that age. The efficiency of the cardiac as well as involuntary muscles also is gradually diminished as age advances.

Endocrines: β-cells of the cell-islets of Langerhans of the pancreas, in quite a number of cases, become fatigued, exhausted and inefficient and so many with sedentary habits after 50 years of age develop diabetes mellitus. The glucocorticoid and adrenaline secretion by the adrenal cortex and medulla respectively are less, so that old people cannot easily overcome the stress and strain of diseases or adverse turmoils of daily life. The parathyroids are often over-active leading to slow but steady drainage of calcium from the skeletal bones. So a condition known as osteoporosis results, which is responsible for back-ache and attacks of pain in the shoulder, knee and other joints. Females as a rule, are more prone to such maladies, especially back-ache and radiating pains from the spines, due to lack of œstrogen secretion that stimulates the osteoblasts after the onset of the climacteric.

In females ovaries lack the normal secretion of œstrogens leading to the onset of menopause some time between 42 and 52 years. This not

only puts a stop to their normal reproductive function but also has other consequent effects on their body and mind. The full and corpulent breasts lose their tightness, hang loose with deterioration of what is known as attractive figure. Vasomotor and other autonomic disturbances in the form of hot flushes, excessive sweating, irritable temper etc. are very common features.

In males due to deficiency of testosterone, the testicular hormone, a condition very much similar to menopause in females, known as the 'male climacteric' may, as well occur, with similar symptoms together with forgetfulness, ennui, ficklemindedness and incapacity for prolonged physical or mental exertion.

The Skin: It gradually loses the natural tautness and characteristic glossiness of young age and as age advances well marked wrinkles on the face,

Fig. 3. Forehead and face of a very old Negro woman showing innumerable wrinkles with crow's foot.

forehead, and crow's foot on the lateral side of the eyes make their appearance (Fig. 3). According to Allison[1] senile clastosis of the skin with destruction of collagen in the corium has been related to an enzyme lysosome activity, which enzyme along with another, ribosome by name, has been

[1] Allison, A., *Scientific American*, 1967, 217, 62.

localized within the cell by electron microscopy and ultracentrifuge. Probably osteoporosis occurring in the elderly females owing to hormonal disturbance after menopause, is also partly due to extra amount of lysosome function. While the sweat secretion usually increases the secretion of the sebacious glands diminishes, causing senile pruritis. There is also increased pigmentation on different regions of the body so that the complexion becomes darker.

Bones and Teeth: Besides osteoporosis of the skeletal bones, the intervertebral discs wear out, so that the vertebrae on both sides droop and approximate to each other causing pressure upon the nerves of the brachial and femoral plexuses, responsible for pain radiating down the superior and inferior extremities. The bones become more brittle from an increase in the inorganic salts and the cartilages also become more rigid and calcareous.

As age increases the enamel of the teeth decays owing to acid formation by the organisms acting upon the food particles that stick in between the teeth whereby nerve filaments at the root of the teeth are exposed causing frequently toothache. Gradually the roots of the teeth become loose after inflammatory swelling in the gum and ultimately they fall out.

Hairs and Nails: Due to faulty pigment metabolism the hairs become gray, at first with glistening silveriness here and there on the head and ultimately the whole caput becomes hoary. The nails too, lose their normal smoothness and reddish polish and ultimately become scaly or brittle.

Nervous System

1. *Cerebrospinal:* The nerves as a rule very often become hyperexcitable with brisk knee and other jerks, although after 80 the deep jerks are found to diminish in strength. Inspite of the fact that neither the spread of conduction of stimulation in the nerves nor the duration of simple reflex activity undergoes any alteration with age the reaction times are much slowed down especially in the more complicated task with more number of neurons required for its performance. There is a general slowing of the motor and sensory activity. The capacity for learning new things is diminished although memory for facts and vocabulary remains constant. Old men as a rule, do not sleep well and even do not require it for more than five hours daily. The sleep too is not deep and continuous and often is disturbed for answering call of nature frequently. Most of the old people suffer from senile psychosis with sleeplessness, restlessness and agitation at night and at times with mental confusion, delusion, emotional instability and depressions, sometimes with a weeping tendency.

2. *Autonomic:* The Autonomic nervous system (ANS) has to bear most of the brunts of the advancing age (Frolkis[2]). In old age the range

[2] Frolkis, V. V., *Triangle*, 1968, 8, 8, 322-328.

of reflex responses involving the ANS reaches its maximum sooner. The correlation between the reaction intensity and strength of the reflex stimulation of the sensory nerves is less predictable and clear-cut. Experiments on old rabbits and cats after stimulation of the sensory nerves and receptive areas with increasing intensity showed that the autonomic regulatory mechanisms are defective and so there are gross changes in the hæmodynamic respiration and blood sugar levels, sometimes to a dangerous degree. Both in animal experiments and human studies, with increasing age the recovery time is much prolonged, or in other words the time necessary for the return of the functions to the original level is much longer than usual. The latent period is increased and the vascular reactions are always protracted. When old persons are subjected to autonomic reactions repeatedly, fatigue is much earlier in its onset than in the younger subjects. With advancing years there is a decline in the sympathetic and parasympathetic effects and in consequence the sensitivity of the cells and tissues to the action of mediator substances secreted in the postganglionic synapses of the autonomic nervous system, so that cell metabolism and function respond to a very small dose of agents and especially the sympatho- and parasympatho-mimetic ones. Thus very minute doses of the latter such an acetylcholine, insulin etc. very often cause lowering of rate and force of heart, fall in blood pressure, diminished blood sugar level and changes in endocrine functions in old animals. So increased sensitivity to these mediator substances together with other factors contributes to the important mechanism for maintaining cellular neurohumoral regulation in old age.

With age advancing, there are functional changes also in the sympathetic and parasympathetic ganglia, showing a decline in the ganglionic excitability and lability (assessed by the maximum number of impulses transmitted per second). Such changes reduce the capacity of the organism to transmit informations from the Central Nervous System (CNS) to the periphery and thus limit the adaptive power of the ANS. The associated cells and tissues are guarded by the reduction in the lability of the autonomic ganglia and postganglionic synapses against the injurious effects and sudden changes in the activity of the nerve centres.

With increasing age the tonic effects of the parasympathetic and sympathetic nerves on the heart are diminished. So it may be taken for granted that as age advances there is a decrease in the influence of the autonomic nerves with a consequent increase in the sensitivity of the cells to humoral factors.

The part played by the ANS for regulation of the metabolism in its various aspects and other functions is under the control of hypothalamus of the CNS, which influences changes in the activity of internal organs with increasing age. From experiments with rabbits and rats it has been definitely observed that with advancing years there is a decline of hypothalamic control over the functional systems. On the other hand blood

pressure changes elicited by stimulation of the nervous structures by stronger currents in old animals show that excitability of at least some centres is increased rather than diminished. The changes so effected exhibit not only quantitative but also qualitative shifts in the regulation of metabolism and other functions and so a new complicated interrelationship between the two components of the ANS is set up. There is also an increase in the sensitivity of the central nerve structures to humoral factors over and above the changes in their relationships, already mentioned.

Some other substances are also found to cause changes in the electrical activity of the brain in smaller doses in old animals than in the young adults, which effect is not due so much to changes in the sensitivity of the nervous structure as to alteration in the permeability of blood brain barrier. It was formerly believed that in old age central structures become more sensitive to some hormones and mediator substances but recent experiments have disproved this idea as it has been found that after introduction of acetylcholine direct into the nerve structure of old rabbits, in most of the cases, the pressor reactions are more pronounced than in the young adults.

Although with age advancing, many of the functional changes in the nerve centres are usually not reflected to the periphery, reactions may be noticed in the corresponding effectors.

Adequate feed back signals from centres supplying informations of important events at the periphery, such as vascular chemo- and pressor reflexes, are very much needed for the requisite amount of ANS control. Experiments on rabbits and cats showed that while vascular chemoreceptors became more and more sensitive in old animals the vascular baroreceptors appeared to be more so for the production of reflexes.

In old age the amount of synthesis of acetylcholine, the specific mediator substance in the cholinergic nerve terminals and autonomic ganglia and also in the heart and skeletal muscles, is reduced and choline esterase activity (hydrolysis of acetylcholine) is found to be reduced more or less in various organs of old white rats. Peculiarities in cholinergic effects in old age in the cells can be very well explained by changes in acetylcholine metabolism. Diminished choline esterase effects and changes in the cholinergic receptors definitely increase the sensitivity of the cells to the mediator acetylcholine.

The other important mediator (noradrenaline) content (secreted by the adrenergic fibres) of the heart and skeletal muscles falls with advancing years, free noradrenaline being diminished to a greater extent than the protein-bound one.

In addition, such geriatric changes in the ANS also have to do a lot for the production of a number of diseases specifically and commonly found during old age.

Sensory Organs: Old people, as a rule, find it difficult to adapt to the changing world around them, which shrinks in size, so to say. Due to diminution in number of ganglion cells in the peripheral sensory organs all the special senses, sight, hearing, smell and taste, become less acute (Verzar[3]). As a result of such decline in sensory acuteness there is less power to make voluntary and involuntary adjustments in physical and mental spheres. There is also loss of sense of vibrations and pupillary reflexes as age advances. Dysmetria is also found in about 20 p.c. of old persons.

In man with advancing years 'arcus senilis' appears around the iris and there is a gradual reduction in the amplitude of visual accommodation, a condition known as *presbiopia*. This results from a gradual loss of elasticity of the optical lens and loss of tonicity of the ciliary muscle so that the near vision is obtained with great difficulty as in hypermetropia (long sightedness) and requires reading glasses (biconvex) for its correction. This condition, curiously enough, disappears after 15 or 20 years of its onset, due to relaxed condition of the suspensory ligaments and what is known as 'second sight' may appear in very old age (if luckily cataract or glaucoma has not supervened in the meanwhile).

With fairly advanced years sometimes loss of plasticity and elasticity of the lens occurs as a result of gradual sclerosis. This is known as *cataract* which may be a specific senile condition, simply occurring as a manifestation of age with no disease or deficiency as a contributory factor. The process leading to opacity of the lens is not inflammatory but only degenerative in nature. The opacity begins in the deeper part of the cortex of the lens without encroaching upon the nucleus. Accumulation of fluid between the lens fibres causes the lens to swell up with the anterior chamber of the eye becoming shallower. As long as the superficial layers of the cortex are clear the cataract is immature but it becomes mature when the opacity has extended to include the superficial layers also, when the water content returns to normal. After the stage of maturation disintegration takes place so that the cortex becomes softened to a pultaceous mass (hypermature stage) and shrinkage of the lens results (Best and Taylor[4]).

In the condition of cataract there is a progressive coagulation of the lens proteins. There is also an increase in the insoluble albuminoid and a decrease in the soluble proteins and glutathione. Calcium is enormously increased with a rise in the concentration of magnesium, sodium and silicates and great reduction in the potassium content. The most accepted conception about the coagulation of the lens proteins causing cataract, is that it is due to prolonged action of ultraviolet light and in some instances to the thermal effect of infra-red rays. But as the incidence of cataract is much higher in diabetes mellitus (in old age or even earlier) the opacity

[3] Verzar, F., *Triangle*, 1968, 8, 8, 299.

[4] Best, C. H. and Taylor, N. B., *The Physiological Basis of Medical Practice*, 7th ed. 1961, William & Wilkins Co., Baltimore, p. 1392.

of the lens is attributed also to the action of dextrose and possibly of acetone bodies which render the lens proteins more readily coagulable by light. But Duke-Elder thinks that the osmotic relation between the lens and the surrounding fluids is disturbed by the high blood sugar level, which interferes with the nutrition of the lens.

In old age very often the three oscicles inside the middle ear become sclerosed, so that there is interference with hearing due to their inability to conduct sound vibrations from the tympanic membrane to the internal ear.

Reproductive System: Reproduction is extinct in the case of females with the onset of menopause (between 42 and 52 years) due to failure of the ovum formation by the ovaries. But the reproductive life of the males is much longer than in the female counterpart. Spermatogenesis may go on unabated in a healthy male up to the 80th year or even more of age, although in some rare cases the number of spermatozoa in semen may diminish to some extent and their motility may also diminish as one advances towards a ripe old age. The libido in the case of old men remains quite intact up to a good old age although it surely undergoes a decrement in the case of females after the 'change of life'. But it is not true that their sexual urge entirely dies out after the climacteric. Even then their sexual desire continues for a varying number of years although their reproductive phase of life has been long over.

Chapter II

CAUSES OF AGEING : CELLULAR CHANGES IN THE TISSUES

About 80 years ago when Brown Sequard[1] (1889) reported his novel experiments on rejuvenation with the help of testicular extracts the attention of the scientific world was drawn to the problem of counteracting ageing but it was a very transient buble in the calm water, which disappeared very soon. In 1908 Metchnikoff[2] elaborated a theory that ageing was caused by intoxication of the bowels. Bayliss[3] in 1920 thought that ageing was 'a philosophy rather than a discipline of experimental science', which was supported later on by Gellhorn[4] in 1931. Steinach's rejuvenation experiments[5] (1921) opened up a new vista for solution of this problem, as after 'Forty years of Biological and Medical Experiments' he said in conclusion that such experiments may make possible "not a land of eternal youth but one of bearable old age to which within natural limits the physiological conditions of life can be made to predominate". Max Burger,[6] however, in 1947 after persevering biochemical and biophysical experiments formulated an interesting philosophical theory of ageing based on his concept of 'Biomorphose and Biorheuse'.

As no definite solution of the problem of ageing has yet been arrived at, scientists are busy in exploring experimentally whether only one factor or a combination of several factors, physical, chemical, physiochemical, psychological, social and economical is responsible for this inevitable malady. It is now widely accepted that the main reason of ageing ending in death is the failure or death of the individual cells throughout the body. This explains why senescence particularly affects those tissues in which cells are not replaced by new ones formed by cell division, mainly in nerves and muscles including cardiac muscle cells. The liver cells are exceptions as they do not lose power of growth by mitosis and so dead or exorcised cells cannot be replaced if hepatic cells are severely damaged by disease or extremely heavy stress.

As regards cause for ageing, at present there are two schools of thought: (1) Wearing out of individual cells of an animal in the course of time ultimately causes senescence and decay, (2) The whole body somehow,

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[1] Brown Sequard, C. E., *C. R. Soc. Biol* (Paris), 1889, 41, 415,

[2] Metchnikoff, E., *The Prolongation of life, Optimistic Studies*, Puttam's Sons, Ltd., London, N. 1908.

[3] Bayliss, L. E., *Principles of General Physiology*, Longman's, London, 5th ed., 1920.

[4] Gellhorn, E., *Lehrbuch der Allgemeinen Physiologie*, Thieme, Leipzig, 1931, 6.

[5] Steinach, E., *Sex and Life, Forty Years of Biological Medical Experiments*, Viking Press, New York, 1940

[6] Burger, M., *Alwern and Krankheit*, Thieme, Leipzig, 1947.

piles up deleterious products in the tissues to such an extent that the cells become unable to perform their functions efficiently but recent animal experiments have proved that as an animal ages the number of cells carrying mutatic chromosomes also increases rapidly, which is further accelerated by radiation, especially of u-v light and thus may have to do something with normal ageing in the course of time.

According to Starling,[7] symptoms of old age may appear too prematurely due to some hormonal disfunction as well, *e.g. Simonds' disease* with lowered metabolism, cachexia, loss of sexual function and premature senility, found to be associated with generalized hypofunction of the anterior lobe of the pituitary gland. So also another condition probably of pituitary origin is *progeria*, where senescence appears dramatically even in a child, and after premature death the adeno-hypophysis is found to be atrophied on postmortem examination.

Old persons always show deterioration almost all throughout the body and so body mechanism all over except in brain cells is hopelessly beyond repair. But the brain too may start deteriorating if one does not perseveringly attempt to keep the mind active.

After a detailed study of the ageing of the cells and their components, Cowdry classified various cells of the body according to the ageing process, *e.g.*

(1) Vegetative intermitotics, *e.g.* spermatozoa, basal cells of the epidermis etc. with shorter lives.

(2) Differentiating mitotics, *e.g.* erythroblasts and superficial cells of the skin.

(3) Reverting post-mitotics such as cells of the liver, kidney and thyroid which may die on ageing but under certain conditions may rejuvenate and divide also.

(4) Fixed pre-mitotics, such as erythrocytes, leucocytes, muscle and nerve cells which being highly differentiated cells do not divide any further.

As age advances more spontaneous mutations occur in the somatic cells due to mitotic errors, which according to Curtis[8] is one of the main causes of ageing as mutations of DNA molecules can only produce such proteins as are capable of carrying on normal cell functions. Hahn and Verzar[9] also showed that DNA in nondividing cells is particularly subject to ageing and senescence. Other factors are also responsible for it.

The most recent and generally well accepted theory about the causation of ageing is based on the alteration in DNA in the nuclei of cells. In young age, as a rule, the genetic code of some hereditary diseases like

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[7] Lovat Evans, C. (editor), *Starling's Principles of Human Physiology*, 7th ed. 1936, J & A Churchill Ltd., London, 1003 (Figs 519 & 520) and 1004 (text).

[8] Curtis, H. J., *Science*, 1963, 141, 686.

[9] Hahn, Von, H. P. and Verzar, F., *Gorontologia* (Basel), 1963, 7, 105.

diabetes, cancer, anæmia etc. in DNA lies dormant but in advancing years the specific code slowly and gradually manifests itself, so that the functional competence and skill of both DNA and RNA molecules are reduced. As DNA, in such a condition, fails to transmit timely the specific message to RNA formation of new cells to replace the old degenerated ones is hampered and consequently senescence results.

Pincus and associates[10] found that oral administration of steroid hormone mixtures in certain proportion resulted in significant increase in the weight lifting capacity of old subjects and are of opinion that steroid hormones are concerned at some stage in the occurrrence of deleterious effects of ageing and also that this stage is a reversible one. There are reasons to believe that the functional capacity of the adrenal gland does decline with age and might in some way be responsible for the process of ageing.

Shock[11] of Baltimore and Max Burger found that homœostatic regulation by way of respiration and kidneys are defective in advancing years and due to this declining power of homœostatic regulation not only there are changes in the lipid metabolism and diminished muscular efficiency but also there is a gradual loss of ability to adapt and to adjust to the changing conditions of life.

Morphological histology showed that in mammals and men too the ganglion cells (especially by counting the conspicuous Purkinje cells of the cerebellum) become less in number due to destruction with increasing age. The same has been later on noticed also in the cerebral cortex, thalamic nuclei, anterior horn cells of the spinal cord and in connection with the peripheral sensory organs. This is explained by the fact that as in the case of other non-renewing molecules the apparently formed internal bonds produce aberrations in the transmission of the code due to stiffening of the molecules. Be that as it may, the metabolism of the ganglion cells is intimately connected with cerebral blood flow and oxygen consumption.

Collagen which forms about one third of all the proteins in the form of connective tissues, having a largely known structure of the molecule in the form of a helical filament is very similar to DNA of the ganglion cells. Being not renewable during life it is also subjected to senile effect. So with ageing there are changes in solubility and swelling properties in 'denatural tension'. Based on these facts it can be surmised that various intramolecular and intermolecular cross links are formed during the process of ageing. The best examples are DNA of the ganglion cells and collagen of the connective tissues (Verzar[12]).

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[10] Pincus, G., *et al*, *Recent Progress, Hormone Research*, 1955, 11, 307, Academic Press. New York.

[11] Shock, N. W., *Trends of Gorontology*, Standard University Press, 2nd ed., 1951.

[12] Verzar, F., *The Ageing of Collagen Fibres*, In Internationales Europaisches Symposium, Experimentelle Alensforschung Experimentia (Basel), 1956, Suppl. IV.

Recently electron microscopy and ultra-centrifuge have provided evidences about the structural alterations in the cells and also those of the ultra-structural ones of the subcellular structures with increasing age.

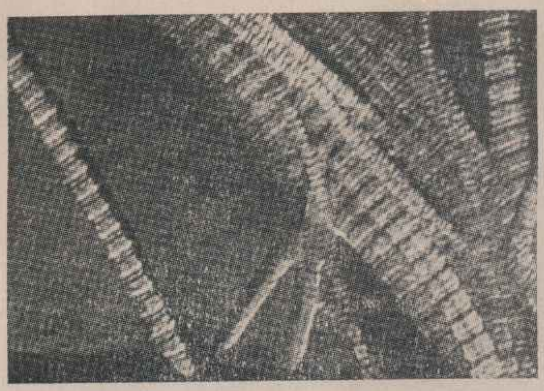

Fig. 4. Electron micrograph of collagen fibres from human tendo-achillis.

So also alterations of enzymic and chemical activity in the cells have been studied by histochemical methods. Thus the enzymes of the tissues have been found to be largely localized in 'lysosomes' and 'ribosomes' inside the cells, of which the former contain the hydrolases or the cell destroying enzymes. These particular enzymes cause destruction of collagen in the corium, so that the elasticity of the skin diminishes in senile condition. Probably osteoporosis which is the cause of backache and excrutiating pain radiating from the spine, due to hormonal disturbance at or after the 'change of life' in females, may also be explained similarly (Verzar[13]).

For the study of cellular ageing cells are divided into two classes, (*i*) the fixed post-mitotics or the specialized cells and (*ii*) the intermitotics or the undifferentiated cells as the hepatic cells which are capable of cell division. As it is not possible to know the age of the second class of cells, only the first class as the individual neuron, in which the age of the cell is approximately equivalent to the age of the organism, are conveniently studied with results.

Pigmentation (especially ceroid) of the nerve cell is supposed to be a senile change but as the amount of pigment deposited in a neuron may be due to various environmental factors, it is doubtful if simply increased pigmentation in nerve cells can be indicative definitely of ageing. It is postulated that during old age pigments are derived in the nerve cells from lysosomes and breakdown of lysosomal membranes is responsible for the release of hydrolases into cytoplasm, resulting in senile decay and ultimately death of the cell. Although there is no indication that mitochondria in nerve cells change with age, some of the Golgi complexes in

[13] Verzar, F., *Triangle*, 1968, 8, 8, 300.

the nerve cells are changed in the old animals, so that there are distensions of the membranes with large vacuoles and increase in the size of the Golgi vesicles. Thus the membraneous appearance of the whole complex is no longer noticed. If, however, animals are subjected to chronic hypoxia the mitochondria diminish in number and the tissue swells up. In such conditions the ganglion cells show not only swollen mitochondria with degenerated cristæ but also enlarged Golgi vesicles, presence of lipofuscin pigment and parallel stacking of endoplasmic reticulum (Sulkin[14]). (Fig. 5, 6, 7 & 8).

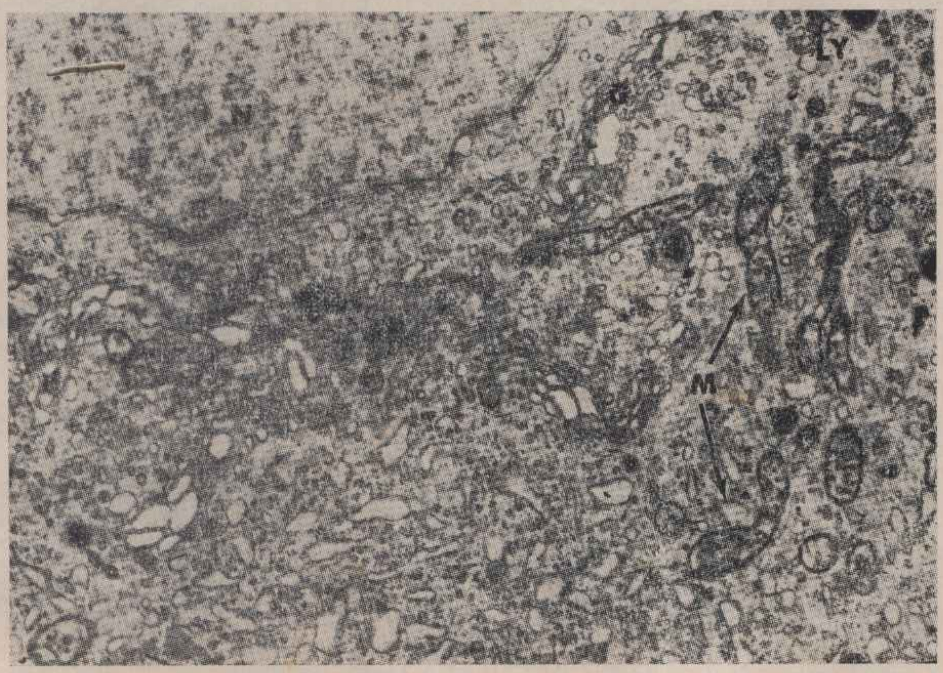

Fig. 5. Electron micrograph of a portion of autonomic ganglion cell from a 118 day old rat. Magnification 16,000 ×. M, mitochondria; N, nucleus; G, Golgi complex; Ly, lysosome (Reproduced by kind permission from *Triangle*, the Sandoz Journal of Medical Sciences, vol. 8, No. 8, 1968. p. 306).

The following changes are noticed in the intermitotic cells of the different organs:

(1) *Liver:* Collections of dark cells of which the deeper ones contain hyper-pigmented nuclei, are probably very old or dying cells. But the possibility of their being artefacts produced in the process of cutting fresh tissue and compression of parenchymal cells against firmer adjacent connective tissue, also cannot be ruled out. Brown atrophy of the hepatic cells which is commonly found in cardiac failure, malnutrition, diminished portal circulation and after hypophysectomy, is also very often found

[14] Sulkin, N. M., *Triangle*, 1968, 8, 8, 305.

Fig. 6. Electro micrograph of portion of autonomic ganglion cell from a 1003 day old rat. Magnification 21,000×. M, mitochondria; N, nucleus; G, Golgi complex; Ly, Lysosome, MV, multivesicular body ; LP, lipofuscin pigment.

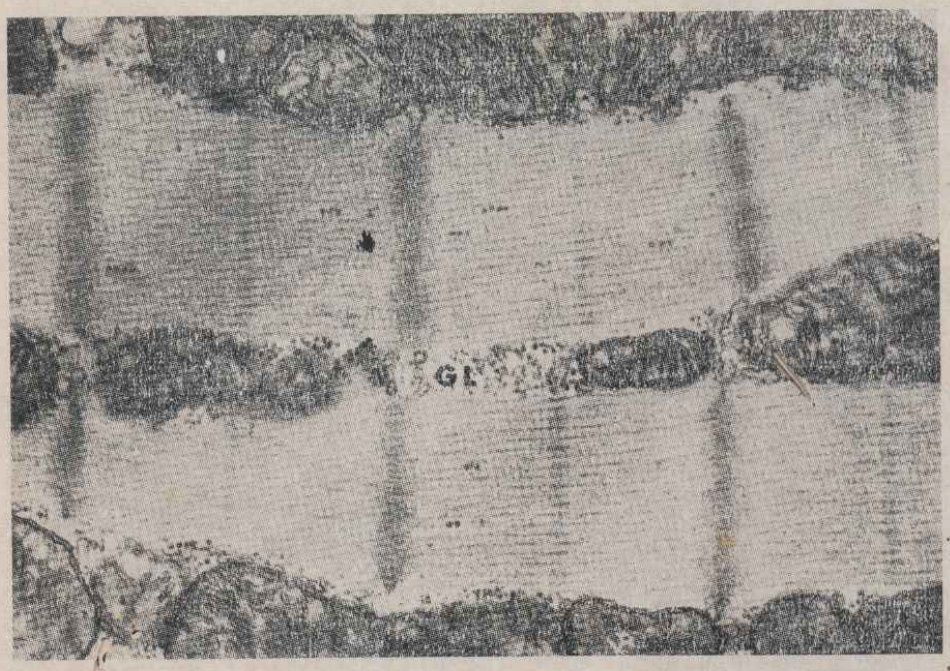

Fig. 7. Electron micrograph of section of cardiac muscle from a young rat (118 days old) which had been in the anoxic chamber for 28 days at a final oxygen level of 5.5%. The muscle appears normal. Magnification 32000×. M, mitochondria; GL, glycogen. (Reproduced from *Triangle*, the Sandoz Journal of Medical Science, vol. 8, No. 8, 1968, 307 and 308).

during ageing together with accumulation of pigment in the older liver cells. Nuclear changes in the hepatic cells including giant nuclei and an increase in the nucleo-cytoplasmic ratio have also been reported by some but it cannot be taken for certain that such changes are definitely due to old age.

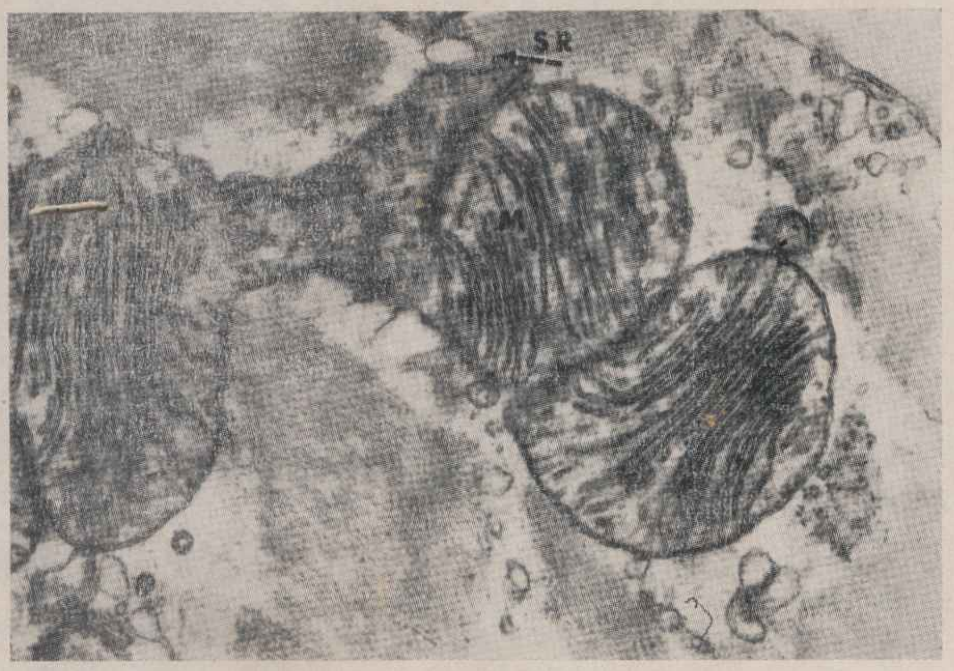

Fig. 8. Electron micrograph of section of cardiac muscle from a senile rat (1030 days old) which had been in the anoxic chamber for 26 days at a final oxygen level of 8%. Compare with figure 7. Magnification 32,600×. M, mitochondria; SR, Sarcoplasmic reduction. (Reproduced by kind permission from *Triangle*, the Sandoz Journal of Medical Science, vol. 8, No. 8, 1968, 310).

(2) *Spleen*: In old rats the compact reticular tissue is changed into mostly sinusoidal type and thus there is loss of follicular tissue with very indistinct demarcation between the red and white pulp.

(3) *Kidneys*: Andrew and Pruett[15] observed some multinucleated aberrant cells in the kidneys, with amitosis or fusion. The number of mitosis in the tubular epithelia is less in old animals than in the young ones.

(4) *Thyroid gland:* With age advancing there is a distension or obliteration of the follicles with flattening of the epithelium and the mitotic activity of the cells is diminished. The colloid content is also altered and the reticular connective tissue is replaced by a collagenous one. In some cases hypertrophy of the follicular epithelium has also been noticed during ageing.

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[15] Andrew, W. and Pruett, D., *Amer. J. Anat.*, 1957, 100, 51.

(6) *Adrenals:* Senile changes noticed in these glands are increase in the fibrous material, accumulation of pigments and sometimes proliferation of cells to form small nodules. Such distinct degenerative histochemical changes, according to Selye[16] are suggestive of altered functional states of the glands as have been observed by the fact that survival power of mice to cold stress is markedly diminished with age.

(7) *Testes:* Active spermatogenetic cells are always found in the testes of very old people and so there is no definite evidence that formation of spermatozoa ceases at any particular age. Seminal discharge of even senile persons, barring some exceptional cases, shows quite a good number of living spermatozoa, both active and motile. There is no evidence of any change except an increase in pigment, in the interstitial cells which as a rule, do not alter in structure or in number during ageing, although it is believed that functionally they become less potent for the secretion of the testicular specific hormone, which is the basis of rejuvenation experiments.

Sulkin in his concluding remarks says, "Organisms age and eventually die. It is also evident that with age organs undergo deteriorative changes. It is more difficult, however, to relate the deterioration of the organism, and in such cases, of its organs, with structural changes in the cells which make up the organism. Ageing is a complex phenomenon which probably results from numerous processes that take place in the body. We cannot yet assign the role of age change to any individual process".

[16] Selye, H., *Stress of life*, 1956, McGraw Hill Book Co., New York.

Chapter III

THE PSYCHOLOGY OF OLD AGE

All over the developed and also the developing countries of the world, the number of old people is continually on the increase. Modern medicine and hygiene have helped immensely to lead to an enhancement of the longevity of the people with late appearance of the ageing processes as well as better health and sounder mind, as compared to those of the previous generations. This is an achievement no doubt, but the ever increasing stress and strain of the present age on life in the struggle for existence, have created newer problems especially for those who have overlived, so to say, the usual life-span of their predecessors of the last century.

These problems are due to (*i*) deterioration of the social standard of the old, (*ii*) impractibility of individual due attention to the old people because of their ever increasing number, (*iii*) conservative ideas and less power of adaptation to the changing world and unaccustomed circumstances owing to functional retardation or difficulty in establishing new libidinous relationships or a tendency of regression towards a second childhood, so to say, or an escape from a prospectless and gloomy future.

In the changing world respect for age which was a characteristic feature of most of the civilized societies even before the great world war II, has almost disappeared giving place to an indifferent attitude, nay hostility, of the younger generation towards the 'old fools'. With retirement from office or vocation where one day earlier he was a respected and honoured member, but only one day later he is no body, unwanted and unneeded, he has to make room for the ambitious younger and more energetic candidate. The old retired man without any job feels bored and thinks that he has come to an end of his useful existence. A man of such an outstanding personality and position in the medical profession as Sir William Osler, while speaking as an old man at Johns Hopkins University deplored the period of uselessness most men must endure after 60 and even went so far as to say that he fully endorsed the scheme proposed by Anthony Trollope in his famous book *The Fixed Age*, in which it has been narrated that men at 60 should retire for a year of contemplation before a peaceful departure by chloroform (Donahue[1]). In the case of those who do not favour the idea of final exit at 60 by such 'Oslerization' as termed by contemporary press, the very thought of living on a pittance or a meagre pension or gratuity and faced with the prospect of dependence on younger generation, for the rest of life, makes him restless and extremely nervous so that he has no other way than to seek

[1] Donahue, Wilma, *Merill-Palmer Quarterly*, Winter, Detroit, 1955.

recourse to religious pursuits as a shelter. He has a very restricted social life only amongst his own age group in some clubs or parks, where his only relaxation is gossip of social scandals, rumination on conditions prevailing in the golden past and expression of dissatisfaction with the changing world in general and the unbecoming behaviour of the daughters-in-law and sons-in-law in particular.

Such old retired men are often subjected to restlessness, mental confusions as delusions, emotional instability, depressions with a weeping tendency and at times extreme nervous agitation, which are all very common features of the senile psychosis. Many of them are given to extreme pessimism and such endless adverse psychoses sometimes lead eventually to 'retirement death' and even to suicide.

The old women are also no exceptions. Besides many factors of the old age common with the old men-folk, mentioned above, the females with the onset of the climacteric think, now that the prospects of maternity are gone for ever, their lives are no longer worth-living. Failure of the hormones of the ovary tells upon their body and nerves so much that they become very excitable, garrulous and sometimes quarrelsome. Within the restricted domain of their family circles they are as critical of the shortcomings of their daughters-in-law as they are indulgent about their daughters and grand-children. If the daughters-in-law and sons are not considerate and tolerant, a split in the family circle becomes almost inevitable. With such an adverse effect on the weak and shattered mind of the old women it is no wonder that their health is broken and consequently death is hastened.

If perchance due to better medical help and care the inevitable does not take place for some years after retirement the conflict between the old and the younger generations very easily leads the former to overtax their depleted resources so as to overlook the psychosomatic danger-signal until final breakdown in the mental equilibrium supervenes all of a sudden.

People who are accustomed to a certain standard and way of their own when they get old, very often are deprived of many of the former amenities and special attention which they so much need and crave. So they begin to think themselves neglected. As age advances on the one hand friends become fewer, friendship more feeble, and relations more distant, while on the other, actual needs and demands are ever on the increase. Particularly those who have not got a happy home and an adequate steady income of their own, consistent with their former mode of living, are in a very uncomfortable position especially as regards their bare necessities such as, food, lodge and day to day miscellaneous expenses. There are no facilities in the form of charitable homes in our country for such old destitutes and Government too do not feel that it is their responsibility to provide such needy old people with pensions or doles, as in Great Britain

and other progressive countries. For such helpless aged group, longevity is a curse rather than a boon and placed under the most unfavourable circumstances they are sure to consider their lives nothing but useless and burdensome.

At this critical period they lack the inner strength to cope with the adverse situation by attuning their psychological state to the physiological pattern of their life. Incapable of adapting themselves to the altered circumstances they cannot take the old age with grace and so cannot enjoy their lives any more. On the other hand they become subject to unnecessary mental worries, agonies and bitterness, and also sometimes to extreme depression or melancholia attended with a suicidal tendency. At the root of all these is very often functional retardation or general bodily infirmity due to bad liver, indigestion and intestinal stasis with habitual constipation. Conservatism or an inflexible adherence to the old and obsolete ideas of the bygone days is also to a great extent responsible for the lack of the power of adjustment. An inferiority complex gradually and steadily takes hold of them and as such they cannot make new friends or contact any new attachments. In western countries instances are not rare of septuagenerian or octogenerian bridegrooms or brides going in for marriages for the second, third or fourth time after death of the life's partner, and sometimes even after divorce. But in India although marriages of very old men with quite young brides in their teens or even younger, were in vogue in the past in the then polygamous (polygynous and not polyandrous) Hindu society and even now amongst people professing Muslim religion, such marriages in modern times are few and far between. Moreover, due to regression of mental faculties in the old people (especially at the age of seventy-two, as the Bengali proverb goes), there is a tendency of shift towards childish mentality for the second time, with selfish craving for their own comforts only at the expense of others', may be his own near and dear ones, friends, associates or even neighbours. This extreme self-centredness and selfishness to which the old people become victims ultimately lead them to a stage of distinct melancholia, hypochondriacism and misanthropism. They think that they have no future to count on and the 'living present' is also unbearable to them because it is devoid of any prospect and they go on ruminating over the events of the golden days of the past when they were the masters of the situation which was all favourable for them. But now that the good old days are gone for ever, never to return again, they have nothing to look forward to but the inevitable dismal end.

Chapter IV

PATHOLOGY AND DISEASES OF THE OLD AGE

With advancing years the frail human body is very often subject to certain special ailments as a result of the ravages of old age. The liability of the old to get ill is about three times as much as of the younger adults. With ageing the body suffers from multiple pathology due to continuous wear and tear or to some degenerative changes and various specific ailments. Besides, there are some ill-understood syndromes too, such as, senile weakness, senile pruritis, progressive cerebral ischæmia (with or without senile psychosis), nocturnal restlessness, incontinence of urine and stool, emotional imbalance etc., which affect the old age.

In the first group of ailments besetting old age, commonly met with in persons of more than 65 years of age, may be mentioned thickening of the valves of the heart with murmurs, mild or severe decompensation with hypertrophy or dilatation of the heart, bradycardia, thickening and calcification of the arteries and essential hypertension with high pulse pressure.

The common causes of congestive heart failure in the elderly are arteriosclerosis, hypertension and respiratory failure. Digitalis and mercurial diuretics which are commonly used in cardiac failure may also sometimes lead to toxic manifestations. If already digitalized, the increased sensitivity to the drug due to potassium deficiency, and also post-mercurial redigitalization may cause nausea, vomiting, dizziness, headache and other symptoms which can be relieved by withdrawal of digitalis and administration of potassium salts. Hyponatræmia brought about by too much salt restriction, mercurial diuretics and cation- exchange resins may induce mental disturbances, apathetic condition and anorexia with refusal of food. Ultimately there may develop delusions of persecution and other obsessions, clouding of consciousness, delirium and coma, which may be relieved by sodium chloride administered orally or intravenously according to the severity of the condition.

In the case of myocardial infarction, (Fig. 11) in which according to Pearson,[1] the mortality increases with age, along with routine treatment with drugs like pethidine hydrochloride, atropine sulphate together with anticoagulants, the patient should be made to sit on an easy-chair or on the bed supported by an inclined back rest with his legs stretched, rather than in a completely recumbent position, as Levin[2] by cardiac cathterisation has

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[1] Pearson, H. E. S., Paper read to the Medical Society for the care of the Elders, 1955.
[2] Levin, S. A., *Ann. intern. Med.* 1955, 42, 1270.

proved definitely that the heart, healthy or diseased, has to work 23 per cent more in a recumbent posture than when sitting comfortably in an easy-chair with stretched legs.

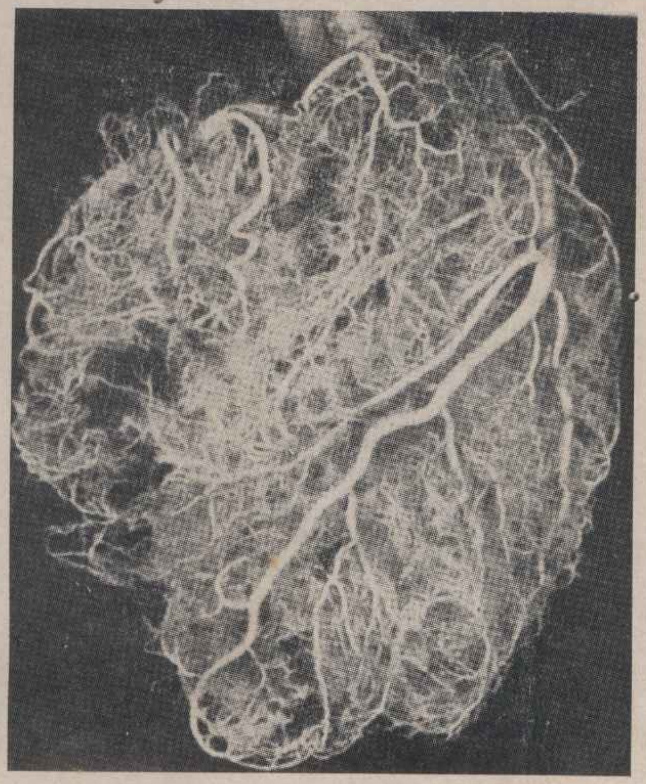

Fig. 9. Normal heart of a 19-year old male showing plastic of normal coronary circulation (*Clin. Ex.* 21, 4, 1951).

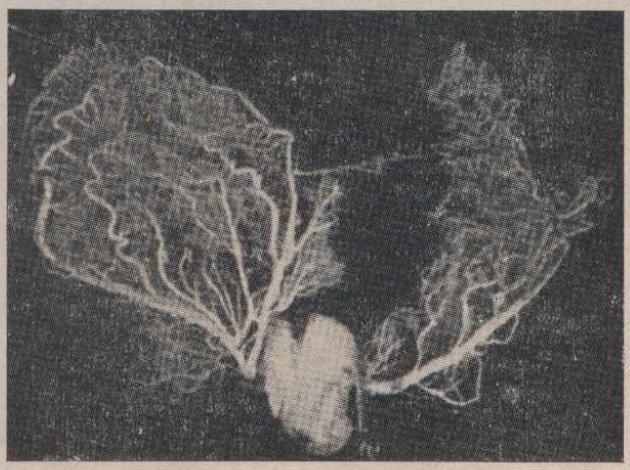

Fig. 10. Plastic of coronary circulation of a 77-year old woman. *Policlinico* (*Sezione Practica*) 61, 26 : 745, 1954.

The arteries of many old persons are rigid and show narrowing of their lumens due to various degrees of atherosclerosis as a result of accumulation of cholesterol (Fig. 12) on or calcification of the walls, giving rise to systolic hypertension, increased pulse pressure and arteriosclerotic aneurisms.

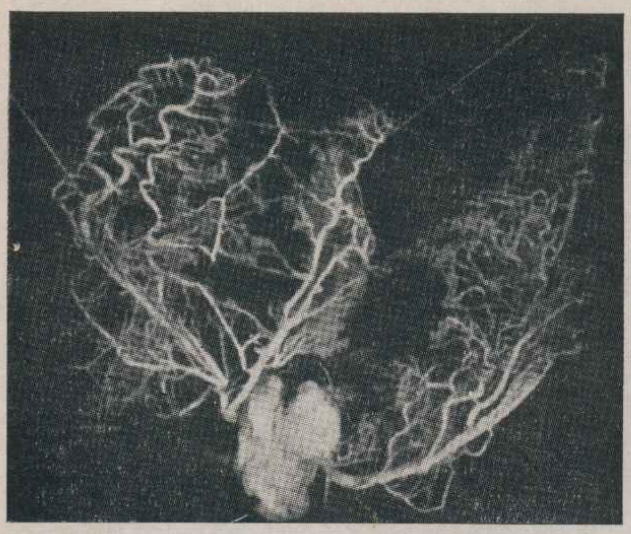

Fig. 11. The same plastic as in Fig. 10, anastomoses and artery interruptions being placed in evidence *Policlinico* (*Sezione Practica*). 61, 26, 745, 1954.

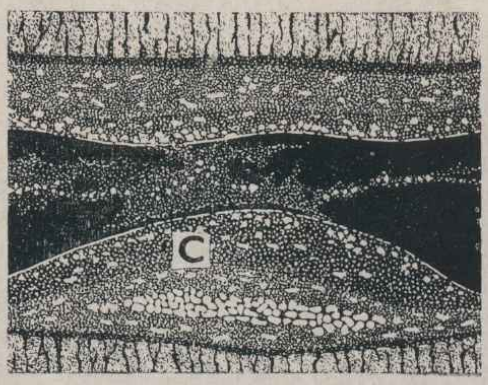

Fig. 12. Longitudinal Section of an atherosclerotic artery with deposit of cholesterol on the wall of an old person sufferring from hypertension. 1. adventitia, 2. media, 3. lumen of the artery, C—deposited cholesterol.

Atherosclerosis of the arteries of most of the vital organs like heart, brain, kidneys, mesenteries etc., usually gives rise to serious complications, such as, myocardial ischæmia, and infarction, mental deterioration, renal failure and abdominal emergencies respectively. Such pathological conditions in

the arteries of the inferior extremities may even cause intermittent claudication, wasting of muscles and sometimes gangrene. In many aged persons appearance of varicose veins in the inferior extremity is also common.

Arteriosclerotic cerebral ischæmia may cause temporary or permanent disability. The temporary and transient effects are paresis of the limbs, blurred vision, giddiness, aphasia and mental confusions. Conditions of longer duration that may result from it are dizziness and according to Alvarez,[3] "little strokes", characterized by loss of smell, bitter taste in the mouth, difficulty in swallowing, choking, acute indigestion, diarrhoea, epigastric pain, abdominal distension, loss of weight, change in personality and sometimes Parkinson's syndrome, dementia and pseudobulbar palsy. But Lassen[4] is of opinion that cerebral sclerosis associated with psychomotor disturbances need not be associated with arteriosclerotic lesions of the minor vessels.

Common respiratory diseases of the old age are chronic bronchitis and bronchiectasis. The former is more common in males than in females and especially during the winter months. This may very often pass to

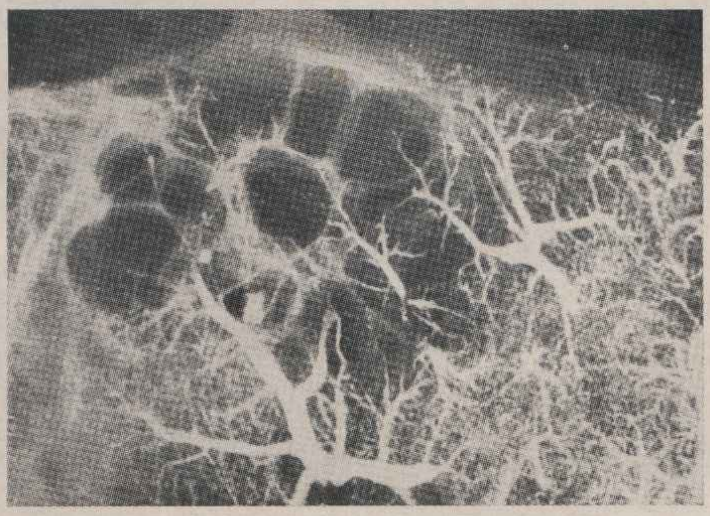

Fig. 13. Angiogram of pulmonary and bronchial veins in severe chronic interstitial emphysema ("church window"). —*Clin. Ex.* 24, 1, 1962.

intractable bronchiectasis, emphysema (Fig. 13) and sometimes to chronic fibroid tuberculosis or bronchogenic carcinoma.

Like backache and radiating pains from spine due to osteoporosis, already mentioned in Chapter II, arthritic or joint pains are very common with the

[3] Alvarez, W. C., *Geriatrics*, 1957, 12, 164.

[4] Lassen, N. A., *Physiol. Rev.* 1959, 39, 183.

elderly people. This may involve large joints like knee, shoulder and elbow due to rheumatism or small joints like carpo-metacarpals as in rheumatoid arthritis or tarsometatarsal and ankle joints as in gout due to faulty uric acid metabolism. These may be further associated with deformities, contractures and trophic ulcers.

Frequency of urine, sometimes with incontinence is often troublesome to very old persons. Lack of power on the part of the vesical sphincter muscle and sometimes irritant substances excreted in the urine are responsible for such symptoms. Prostatic enlargement in the aged males may also be the cause of increased frequency of urine, especially at night with incomplete evacuation of the bladder until a time comes when passing of urine may become impossible due to obstruction by the enlarged prostate, causing agonizing discomfort and pain owing to retention of urine. The cause for enlargement of the prostate gland is not yet definitely known. According to some an excess of oestrone or rather an androgen-oestrogen imbalance causes the enlargement of the gland in old age, while others think that scanty secretion of a hormone, 'inhibin' by the germinal epithelium of the testes due to usual regessive changes (?) after middle age, causes an excessive amount of secretion of testosterone by withdrawal of the restraint upon the gonadotropic hormone of the anterior pituitary, and this is responsible for the prostatic enlargement in advanced age.

Old ladies in the post-menopausal period, sometimes suffer from multiple subcutaneous or submucous small or large haemorrhagic purplish spots known as achymoses. They are not so much due to damage of the capillary wall or thrombocytopaenia directly but are caused by what is known as vicarious menstruation owing to an occasional unusual upsurge of hitherto absent ovarian hormonal influence, after the uterus has ceased to function as a normal gate way for the exit of the menstrual blood.

Mention has already been made of anæmia due to iron deficiency in the old in general and about "bachelor's scurvy" in the old bachelor or widower who lives alone, due to faulty diet lacking in vitamin C. In the latter condition even in the absence of avitaminotic symptoms there is a lack of the normal amount of ascorbic acid in the leucocytes, that prevents inclusion of collagen material in the bone tissue, and thus there are a tendency to fractures and diseases of the costochondral junctions and a delay in the process of recovery if the same existed before.

There are various types of digestive disorders afflicting the old age such as, anorexia, indigestion, dyspepsia, flatulence, accumulation of wind, borborigmy and constipation. Malnutrition, wasting, anæmia etc., which are so common in old age are due mostly to poverty, lack of knowledge of food values and isolation from social contacts. Sometimes too much intake of well spiced and tasteful food, gluttony and voracious eating may be responsible for indigestion, acidity and other

digestive troubles, causing starvation in the midst of plenty so as to result in malnutrition, anæmia and wasting.

Nervousness, headache, dizziness, insomnia, lack of orientation, backache, shooting or dull pain in some regions of the body and dementia are some of the important nervous manifestations, common to men and women of advancing years.

Chapter V

OLD AGE AND MENTAL ACTIVITY

Brain cells remain exceptionally stable and healthy when cells over all other parts of the body show signs of deterioration slowly and gradually as age advances, without any future prospect of repair. "A rolling stone gathers no moss": this applies fully in the case of brain cells. It is an old adage that a man is as old as he feels and the best examples are those intellectuals who consider their old age to be not a handicap but rather a suitable time for utilising their life-long experience for the fulfilment of their creative urge in the domain of art, philosophy, literary pursuit or scientific venture,* and who fully adapt themselves to the changing world around them and thus continue to retain their mental activity unhampered inspite of their advanced age. The body may be frail and weak but the creative functions of the brain continue as energetically as before, sometimes to the last day in case of some of the greatest men in various walks of life, world has ever seen. Even in the spheres of politics with so much responsibility and strain on the nervous system there were many outstanding figures who were at the helm of the affairs of their countries, quite fit and active up to a ripe old age. Mention may be made in this connection of Bismarck (83), Metternich (86), Gladstone (89), Clemencau (88), Giolitti (86), Boselli (94), Hindenburg (87), Croci (87), Orland (92), and Adeneuer (84). Amongst the mathematicians Cassini was near about 100 and Harschell, Fossombroin and many others like Hally, Newton, Bior, Bernoulli and Legendre, all lived for more than eighty years. Amongst chemists, physicists and naturalists, Chevreuil lived for more than a century while Humboldt and Gillet reached very near to 100 years each and Armstrong, Bunsen, Boussingault, more than 90, Berthelot, Franklin, Milne, Edwards, Leydig and Vogt were all over 80. Philosophers as a rule, are found to be favoured with longevity.

The following is an interesting list of outstanding works done by men who were great in different spheres of life after attaining a ripe old age.

(1) Sophocles wrote his famous book *Oedepus and Colonus* when he was about 100 years old.

(2) Isocrates prepared his famous *Panthelicus Lecture* when he was 94.

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* Voltaire mentioned an exception by drawing attention to the fact that physicians were usually not found amongst the centenarians and have an average life-span of 56·8 years only. In support of his contention he cited from the history of his country that one king of France alone, buried as many as forty of his personal physicians. In such a case the longevity of some medical men in other countries and some in our country too, such as Dr. Sundari Mohon Das who died at 93, Dr. Lalit Mohon Banerji at 86 and Dr. Sir Nilratan Sircar and Dr. Bidhan Chandra Roy at 81 or near about and Dr. Nalini Ranjan Sen Gupta (87) who is not only living but is still in active practice, must be exceptions rather than the rule.

(3) Plato, the disciple of Socrates and in turn the teacher of Aristotle, wrote his last book at the 81st year of his life.

(4) Xenophon, the great historian, lived most actively up to 90 years and Xeno, the philosopher was with the same mental vigour when he was 98 years old.

(5) Diogenes, the Greek Philosopher, also lived up to a good 90 years of age, all hale and mentally active.

(6) Marcus Terenius was a versatile genius and there was scarcely any field of wisdom to which he did not contribute up to his 89th year when he breathed his last.

(7) Kato started learning Greek at the age of 84 and became proficient in it. So far as learning a new language at such an age is concerned, he must have been an exception, rather than the rule.

(8) Titian, the famous artist, produced his famous historical picture entitled "The Battle of Lepanti" when he was ninety eight, only a year before his death due to plague.

(9) Michael Angelo's famous pictures "The Last Judgment" and "Moses and Slaves" were drawn when he was 66 and 70 respectively and he engaged himself in the arduous task of converting the old bath of the Emperor, Dioclissian into a church at the age of 89 when he died suddenly.

(10) Luigi Coronaro of Venice wrote at 83 his famous book *How to Own a Long Life*, which underwent four editions before he died as a centenarian.

(11) Peter Hobbs, the English philosopher, wrote his autobiography in Latin when he was 84 and brought out in English translation of *Poetry of Odyssey* (in four volumes) at 85 and of *Illiad and Odyssey* at 87. He died at the ripe old age of 92 when all his literary talents were still productive.

(12) Tulsidas, the great Hindi poet, wrote his famous *Rāmcharit Mānas* at a good old age and was 90 years old at the time of his death.

(13) Firdousi, the reputed Persian poet, became the author of the famous *Shāhanāma* when he was quite old and lived up to a century.

(14) Another Persian poet, author of *Wastān* and *Gulistān* which were written at a ripe old age, was also a centenarian before he breathed his last.

(15) Krishnadas Kaviraj, the famous biographer of Sri Sri Chaitanya-dev, wrote *Chaitanya Charitāmrita* when he was pretty old. He also lived up to a century.

(16) Jagannath Tarkapanchanan, the most illustrious learned man of Tribeni, completed his *Vibād Bhangārnava* when he was 98 and lived for 15 years more until his death at the 113th year.

(17) Goethe, the great German poet and philosopher, completed the second volume of his work, *Faust* when he was 82, only two years before his death. He was of opinion that "becoming old signifies taking on a fresh occupation".

(18) Victor Hugo, the illustrious French novelist and litterateur, wrote his famous novel *Les Miserables* at the age of 60 and for twenty years more composed many notable poems which contributed further to his world-wide name and fame, already achieved. On his 80th birthday laying down his pen, he exclaimed, "I should like to go on for another 80 years".

(19) Guissepi, the renowned Italian musician and dramatist, wrote his famous opera *Othello* when he was 74, *Falstaff* when he was 80 and *Ave Maria* even five years later. He died at Milan at the 87th year of his life.

(20) Benjamin Franklin was not only famous as one of the earliest wise Presidents of United States of America but also as a great scientist of his age, who contributed to science even when he was 80 years old and lived up to a good old age of 84.

(21) Voltaire, the distinguished French politician and litterateur, wrote his drama, *Irene* when he was 83 years old, only a few months before his death.

(22) Tennyson, one of the Poet Laureates of England, also wrote his 'Crossing the Bar' when he was 83, and died a few months later.

(23) Some of Tennyson's contemporaries, such as Thomas Hardy, the poet, dramatist and novelist, H. G. Wells, the famous writer of scientific fictions and Sir Oliver Lodge, the well-reputed essayist, also enriched the English literature by contributions in their respective fields all throughout their long lives even beyond eighty.

(24) Count Tolstoy, the great Russian intellectual and versatile writer, wrote his world famous novel *Resurrection* when he was a septuagenerian and *What is Art* ? was written while he was much further advanced in years.

(25) Pavlov, the world renowned Russian Physiologist, was very actively engaged in his epoch-making researches, especially on 'Conditioned Reflexes' when he was more than eighty years of age and died in his 85th year.

(26) Thomas Edison, the foremost amongst the modern scientific inventors of the world, invented 'the first long-playing gramophone' when he was more than 80. At eighty-four even a few days before his expiry he was engrossed in his researches on rubber.

(27) Sir Charles Scott Sherrington, a scientist of international reputation in the field of physiological research on nervous system, was carrying on his investigations even when he was nearing 90. He could not attain a century as was expected and died only five years before.

(28) Sir Edward Sharpey-Schafer, another professor of international fame, of Physiology (under whose guidance I had the privilege of working on research in the Edinburgh University when he was 81) died in harness when he was 83 years old.

(29) Another English Physiologist of world-wide reputation, Sir Henry Dale, was pursuing his researches even in his 80th year in 1955 and used to say that he was still 'an excited spectator' of the progress of science.

(30) Prof. Albert Szent Georgy was engaged in his epoch making discovery of actomysin responsible for muscle contraction even when he was 95 years old.

(31) The world-famous Indian poet Rabindranath Tagore continued his excellant contributions to the Bengali literature vigorously up to the 80th year and even composed some poems, swan songs so to say, while lying on his death bed at 81. It is noteworthy that his most illustrious father and some of his elder brothers, each celebrated in his own line, were all long-lived persons dying in the 9th decade of their lives.

(32) George Bernard Shaw, the most reputed dramatist and litterateur of international fame, lived up to a good old age of 94 with all his mental faculties, not only intact also perfectly keen and acute up to the last day of his life, when he had to be admitted to a hospital for operation of a broken leg due to a fall as he lost his balance while cutting with an axe the withered branches of a tree in the compound adjoining his house.

(33) Dadabhai Naoroji, one of the founders and the second president of the Indian National Congress, was also physically active and mentally alert until his demise at the age of 92.

(34) Sigmund Freud, one of the foremost psycho-analysts, world has ever seen, wrote his famous book *Moses and Monotheism* when he was 83.

(35) The world-famous scientist Einstein, the propounder of the 'Theory of Relativity' was always busy with very intricate mathematical problems even when he was an octogenerian.

(36) Sir C. V. Raman, the famous Indian Scientist and Nobel Laureate of 'Raman Effect' fame, was vigorously continuing his useful researches at his own Institute at Bangalore until his death in November, 1970 at the age of eighty-two.

(37) Sir Winston Churchill, the Prime Minister of Great Britain during the Great World War II, wrote when he was nearing ninety, the most elaborate and fascinating account of the war in three volumes for which he was awarded the Nobel prize for literature.

(38) Lord Bertrand Russel, the renowned philosopher and mathematician, died only the other day at the ripe old age of 97, after just completing his autobiography in two volumes.

(39) Mary Baker Eddy founded and published *The Christian Science Monitor* when she was 87, only two years before her death.

(40) Helen Keller, the 'Human Wonder' of the 20th century, displayed rare mental acuteness and brain power even when she was 90. She overcame and conquered three crippling physical disabilities, viz., blindness, deafness and dumbness, any one of which by itself is sufficient to nip in the bud all human faculties and activities, by dint of extraordinary and superhuman mental strength all throughout her long life.

(41) Simon Dish, a Greek poet, wrote at the age of 91 a poem which was adjudged to be the best composition that brought for him the first prize in a competition.

(42) Herbert Spencer was thoroughly engrossed in his writings even in his 83rd year when he died.

(43) Buffon, the reputed Zoologist, commenced his best treatises on Zoology when he was 81.

(44) Alfred Russel wrote his best book in his 90th year and Landor edited the famous *Hervie Idylls* in his 87th year.

Even in India similar examples are not rare. The following are certainly worth mentioning:

(45) Sir Jadunath Sarkar, the famous Indian historian was engaged in his researches on Moghul and Maharastra History upto the last day of his life when he was eighty-eight years old.

(46) Hari Charan Bandopadhyay laboured hard for forty long years and completed his *Bangiya Sabdakosh* when he was nearing eighty.

(47) Haridas Siddhantabagish also did his monumental work, the translation of the *Mahābhārata* in eighteen Parvas, when he was over eighty.

(48) Jogesh Chandra Roy Vidyanidhi, even when he was about 90 years old, was engaged in writing his famous books and learned articles.

(49) Hemendra Prasad Ghosh lived up to a good old age of 85 with all his mental faculties acute and alert, so much so that he was considered as the 'living encyclopaedia of Bengal'.

The following instances of very old but most active and famous personalities are also worth mentioning :

(1) Pablo Piccaso, the world renowned artist, born in 1881, who is still active in his creative art, is of opinion that every person should fix up an optimum age of his choice beyond which he would not like to go and that he has selected for himself this age as 30 years only for all his life.

(2) Amongst the most reputed octogenerian scientists who are still actively pursuing their scientific researches are: (*i*) Otto Warburg, as versatile and zealous as ever, even now spends the entire day in the company of his skilled assistants at the Max Plank Institute experimenting on Cell Physiology. Apart from his work he still enjoys his daily rides, week-end sailing and walking. (*ii*) Fritz Verzar, born in 1886 founded after his retirement the Institute of Gerontology in Basel in 1956 and is even now

carrying on his important researches on gerontology to solve the mystery of ageing and how to check it.

(3) Amongst the living Indians who are still very active both physically and mentally are: (*i*) Raja Gopal Achari (93), the last of the Governor-Generals and now the grand old man of India; (*ii*) Janab Alauddin Khan, the Sitar wizard of India who is now 95 years old; (*iii*) Two Bengali poets, Sri Kalidas Roy and Narendra Dev,* who are still enjoying good health and busy in composing poems, although they are octogenerians, (*iv*) Professor Suniti Kumar Chatterjee who is in his eighty-second year, still participates in various fields of activity, research, knowledge and culture; (*v*) Prof. R. C. Majumdar, one of the most erudite and reputed historians of India is still continuing his historical researches with youthful vigour and energy although he is now over eighty years of age. (*vi*) The famous Bengalee artist Jamini Roy,† who is an institution by himself in the field of Indian art, has just now celebrated his eithty-fourth birth day.

By no means this can be taken as a complete list of very old people in India and other countries, who inspite of their old age, contributed before their death or are still contributing their full quota in different fields of intellectual activities. On a careful search a keen investigator can easily add many more names to the list. The very purpose for annexing this rather long list is to prove that even a very old age, whatever it may be, is no bar to the continuation of the mental faculties if the person concerned continues the accustomed mental pursuits with courage, conviction and perseverance. But it must be a love's work and not one, not to his liking or imposed upon him. That deterioration of the mental faculties with advancing years is inevitable, as some think, is a myth so to say, without any foundation, and such deterioration may be avoided altogether if one has a will to do it. Mind can be very easily and aptly compared to a sharp weapon made of good steel. The more the faculties are cultivated and used the sharper they become but if perchance they are negligently kept out of use, there is every likelihood of the same gathering rust and consequently becoming blunt altogether.

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* He died quite recently on the 19th April, 1971.

† He expired on the 24th April, 1972.

CHAPTER VI

LONGEVITY WITH HEALTH : HOW TO ACHIEVE IT ?

LIFE-span of any person can be divided into three distinct phases; (*i*) that of growth, (*ii*) that of maintenance and (*iii*) that of decay. The first phase depends on the specific hormonal influences to increase the capacity of assimilation of the food taken, with constructive process getting upper hand over the normal daily wear and tear, involving complex chemical changes and transformations in the living matter. In the second, the processes of anabolism and catabolism balance each other contributing to maintain status quo, and as age advances in the course of time this balance is lost and eventually the catabolism or the breakdown process in the third phase becomes more than the constructive or anabolic process, so that decay and senescence result, ultimately causing what is known as natural or physiological death. Growth is surely something more than maintenance of life and the harmful by-products of simple metabolism in the living matter, somehow or other are neutralized or rendered ineffective by the natural process of growth. According to Rubner,[1] body cells necessarily contribute some molecular complexes to the process of growth as long as that continues but with the advent of puberty these anabolic complexes are taken up by the reproductive cells for the specific function of the perpetuation of the species at the cost of providing power for growth and so after the period of maintenance for about 2 or 3 decades only senescence and death inevitably follow in due course.

According to Weismann[2] failure of the somatoplasm partially or completely is responsible for senescence and death respectively in old age. He differentiated protoplasm of two types: (*i*) specific protoplasm of the reproductive elements known as germ plasm, not subject to natural death but having a self perpetuating metabolism and existing and retaining their functional capacity even in advanced years in males and capable of being well preserved under proper conditions outside the body for quite a long time, such as semen for artificial insemination; (*ii*) protoplasm of the cells of the rest of the body, named somatoplasm with a limited existence which is adversely affected in old age. So his idea was that originally protoplasm was endowed with the property of potential immortality and if it escaped somehow or other accidents, diseases etc. it was capable of reproducing itself indefinitely.

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[1] Rubner, *Das Problem des Lebensdauer*, Berlin, 1908.

[2] Weismann—Quoted by Howell, W. M., *Text Book of Physiology*, 7th ed., 1918, W.B. Saunders Company, 1020.

Death of the organism is supposed usually to result from failure of some one or other main metabolic complexes of the body while many of the tissues are still able to maintain their existence if kept under proper conditions and supplied with suitable nourishments. So at present death is supposed to be accidental and as such with proper care life-span can be prolonged more or less. On this basis longevity may be divided into two categories, specific and potential. By the former is meant the expectation of life dependent upon inter-action of two factors, such as inherent constitutional properties of protoplasm and adverse internal or environmental conditions, while the latter means the duration of life that may be expected under a congenial and favourable environment. So when we speak of longevity we usually do not mean the specific and the limited one, but to all intents and purposes we mean the potential one, which every one desires to prolong as much as possible. Our great poet Tagore[3] expressed in one of his poems his desire, not to die at all in this beautiful world but to live always in the midst of human beings.

But how to live longer healthily or in other words to acquire this desired longevity with maintenance of health? It is a question very difficult to answer. People, as a rule, very often make their own assumptions and deductions. They are mere conjectures very difficult to prove. As for instance, in the case of a great Indian Saint Sri Sri Srimat Trailianga Swami who was at Benares in the last century, was supposed to have lived for near about 300 years by asceticism and yogic practices. Zoro Aga, the grand old man of Turkey, who lived for more than 150 years, it is said, attained such good old age due to leading a care-free life with moderation in everything. These are mere surmises and assumptions but we find the authentic record of a very long-lived person, Thomas Parr by name, in the form of an account of his life and report of post mortem examination by William Harvey in volume III of the Philosophical Transaction of the Royal Society of London. A picture of this man by the famous artist Van Dyck (dated 1635) is exhibited in the Royal Gallery of Dresden as numbering 1032. The following account by Harvey about this man of extraordinary longevity is indeed, very interesting :

"He died after he had outlived nine princes, in the tenth year of the tenth of them, at the age of one hundred and fifty-two years and nine months. The immediate cause of his death was attributed to a change of food and air and habits of life, as he was brought from Shropshire to London, where he fed high and drunk plentifully of the best wines."

Voltaire, the famous French writer, lived up to 84th year and was of opinion that for acquiring a long life untiring and honest zeal for continuous

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[3] Tagore, Rabindra Nath—First two lines of the poem entitled "Pran" (Life) in *Kaḍi O Komal*.

work was essential. Gladstone, the long-lived and renowned Prime Minister of Great Britain and Ireland of the late Victorian era, is said to have acquired his longevity by his habit of chewing every morsel of food thirty-two times before swallowing. Recently it has been reported in the newspapers that another inhabitant of Shropshire lived for near about a century and a half and his simple dietic menu consisting of nothing more than rancid cheese, cow's and goat's milk, coarse bread and sour whey, has been specifically mentioned as the cause of his longevity. Pavlov, the great Russian scientist lived up to 85 years and his longevity was probably due to regular exercise of the nature of cycling, riding and gardening in between periods of strenuous mental work. Bernard Shaw was a strict vegetarian and teetotaller, who always relished in sea-bathing and gardening including cutting of withered branches of trees and thus enjoyed his old age not only mentally but also physically.

The Bulgars of the Balkan Peninsula in Europe are generally speaking, a long-lived nation and they consider that their longevity has something to do with the custom of taking yogart as the first item in the menu of food, as advised by the Russian Scientist Metchnikoff. Mention has already been made about the long lived people of Azerbaijan in the Introductory chapter. It has been found that increasing number of long lived people of that State of U.S.S.R. inhabit the regions which are higher in altitude than others. So the temperate climate of parts of this state with higher altitude is supposed to be to some extent, responsible for the higher average longevity of the people there. Amongst them one Sirin Gassanov, who is now 150 years old, is a confirmed teetotaller, while another Majid Agayev by name, aged 132, is not only a strict teetotaller all his life but also has never tasted tea and lives on plenty of honey, cheese and vegetables. So far as they are concerned their reported simple and unostentatious lives, habit of doing moderate manual labour, taking simple food, sleeping with clock-like regularity and abstaining from intoxicating drinks are all probably responsible for attaining such extraordinary longevity.

In India many of the long-lived Hindu widows are customarily strict vegetarians from the time of the demise of their husbands and lead a life of austerity as regards food, drink and clothing, avoiding not only all luxuries but also even some of the essential requirements of life. So probably a strict vegetarian diet (not even including proteins in the form of eggs and some pulses as *Masur dāhl*, which is very funnily named 'Indian Beef' because of its high protein content, almost the same as in meat) and that also as only one square meal a day, has something to do with their prolonged life-span as compared to others'. The sadhus and sanyasins of India, who are generally vegetarians (with a few exceptions, such as, those belonging to the Sri Ramakrishna Order), as a rule, are long-lived persons inspite of the hardships and austerities of their ascetic lives.

In Book (or kānda) VII, anuvāka (recitations) 2, of the *Atharva Veda*[4] appear the following suktas (or hymns) where we find something as to "How to prolong some one's life".

(2) Come thou hitherto unto the light of the living. I take thee in order to live for a hundred autumns; loosening down fetters of death imprecations I set for the future a longer life time.

(3) From the wind have I found thy breath, from the sun I thy sight, what is thy mind I maintain in thee, be in concord with thy limbs, speak with thy tongue not babbling.

(6) The lively by no means harming living herb, the persevering overpowering powerful do I call hither, for this means freedom from harm.

(11) I make for thee breath and expiration, old age (mode of death) as long life time welfare.

(12) Afar (away) niggardliness, perdition and seizure (ग्राही) the flesh-eating *piśācas*, every demon that is of evil nature—we smite away as it were into the darkness.

(14) Let heaven and earth be propitious to thee, not distressing, conferring fortune (अभिश्री). Let the sun burn weal into thee, let the wind blow weal to thy heart, let the heavenly waters rich in fatness (पयः) flow propitious upon thee.

(15) Propitious to the herb (शिवाः सन्तु ते ओषधिः) I have caught thee up from the lower into the upper earth, there let both *ādityas*, sun and moon defend thee.

All these hymns are invocations for prolonging life up to a hundred autumns by warding off death. Pure air, sun-light, heavenly waters, and a life free from all blemishes in the form of perdition, niggardliness, seizure etc. have been mentioned as necessary adjuncts, with the help of some efficacious herbs, to make heaven and earth propitious to grant such a longevity.

The Yogis of India claim that they cannot only prolong their lives by yogic exercises (as *āshans*) and control of breath (*prānāyām*) but also can possess a healthy body and sound mind even up to a good old age. This claim receives corroboration from the fact that many persons belonging to yogic order and practising yoga everyday, not only possess an active healthy body with higher mental faculties, especially concentration of mind but also live much longer than the usual specific longevity. So also *Kāyakalpa*, a purely Indian method of treatment, is claimed to promote rejuvenation in old age if strictly followed.

A perusal of all these diverse factors makes it very difficult to attribute the secret of longevity to any one single factor or combination of

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[4] Whitney, W. D., *Atharva Veda Saṃhitā* (English Translation), 1905, Harvard University, Cambridge, Massachusetts, VII, 2, (2), (3), (6), (11), (12), (14), (15).

different factors which actually converts a specific longevity into a potential one.

Some scientists did some animal experiments while others collected many relevant data so as to come to some definite conclusion as to the real cause for longevity. Professor Petrova of the Pavlov Research Centre at Koltusi near Leningrad, on the basis of her investigations on two groups of dogs, proved definitely that old age and its sequence, senescence are intimately connected with the functions of the CNS and especially the cerebral cortex. Of the two groups, one consisted of dogs, young, energetic and physically strong with sound mind. They were kept for several years under a condition of continuous stress and strain. After the experimental period covering several years they were found not only less energetic, lazy and exhausted but also they showed signs of premature old age and dotage. They were less excitable to stimuli, their legs were weak and shaky even when they were in a standing position, the joints were inflamed and teeth decayed and there were patches of alopecia here and there all over the body, so that at 12 years of age they appeared as old as 20 and some of them even died at the age of 13 to 15 years. On the other hand the second group of experimental dogs comprised of animals of the same age who to start with were weak, docile, less energetic and easily tired. For all those experimental years they were afforded enough rest and nothing was done to excite them unnecessarily or to tax their brains. The health of this group improved gradually as years passed by and their fur, skin, teeth and paws looked like those of younger ones and they appeared to be five or six years younger even when they were 16 or 17 years old.

Another important research was conducted by Dr. Flanders Dunbar, the Director of the department of Psychosomatic Research of the Columbia University, U.S.A., who carried on investigation for 16 long years on 300 centenarians, both men and women, with a view to find a standard for predicting the life-span of any person by recording answers offered by the subjects to a series of relevant questions. According to him, from answers to this series of questions as also observation and scrutiny of the lives of 300 centenarians some tentative deductions have been arrived at on the basis of probability.

Question No. 1 is: Are you married? If your answer is in the affirmative, you can certainly expect to live up to 100 years, because it has been found that of the centenarians 98 per cent belonged to the married group and are not even averse to contact a second nuptial bond on the death of the first wife or after divorce, even at a ripe old age. In most cases their conjugal lives were happy and divorces were few and far between.

Question No. 2 is: Are you content with your vocation and field of activity? If you are, you have the same claim to longevity as the centenarians. When the question was put to them they invariably answered that as they were always at the helm of affairs they had never to undergo

stress and strain of unpleasant orders from any boss or over-lord. Many of them were proprietors of their own concerns while others who were only employees in some others' business and could not pull on well with higher authorities because of difference of opinion, did not hesitate to resign or even to change their residence to seek suitable jobs of their choice, where they would be able to work more comfortably with much less anxious moments.

Question No. 3 is: Is yours a big family? If you say 'yes', that is also favourable for your acquiring a long life. Those who are lucky to live up to a century usually have big families, with double or near about number of children than ordinarily.

Question No. 4 is: Are you a constituent of any Religious Organisation? If your answer is in the affirmative, you have every possibility of living up to a good old age. The long-lived persons are usually religious minded, go to church or temples regularly or offer prayers in the mosque and are of charitable disposition.

Question no. 5 is: Do you like to exert yourself as long as you are fit to work? If you are strong enough to ignore and set at nought the usual age for retirement and are bent upon doing your work life-long, certainly you score another point in your favour. The centenarians, as a rule, do not like to retire from their work, or if compelled to do so according to service rules, keep themselves busy even after retirement. They would very often seek a new job or commence new ventures or at least engage themselves in some hobbies. They would never waste their valuable time in ruminating over events of the 'dead past', and would be bent upon making their 'living present' fruitful with prospects of future success. As they aspire to live for many years more, they are determined to be self-sufficient and independent, physically, mentally as well as economically. For instance, a big bank-magnate handed over the management of his vast business to his son on his hundredth birthday and immediately after, busied himself with the task of organizing an Association for the Welfare of Children. Such voluntary taking up of entirely new assignments is the rule rather than exception with healthy long-lived persons. Their principle is never to shirk work and court ignominous decadence due to inactivity, which is worse than death to them.

Question No. 6 is: Do you live in the midst of bustles and tumults of a noisy big city? If you do, you will perhaps be surprized to learn that this is another point in your favour. Statisticians say that most of the centenarians of Dr. Dunbar's investigation were city-dwellers with residences in the most noisy quarters of the cities.

Question No. 7 is: Are you a sociable person? If you are lucky to have a good number of friends whom you like and in turn you are also liked by them and moreover if you possess a good sense of humour, you score another favourable point for your reaching the hundredth year or near about. The

centenarians, as a rule, are found to have a knack of contracting new friendships as they advance in years to fill up the blanks, if there be any, and are also very optimistic, no matter how old they are.

Question No. 8 is: Do you try to live a peaceful life in the midst of stresses and strains of the present day world? You can certainly draw another point in your favour to win the race for longevity, if you try honestly to face the problems of everyday life complacently with confidence and courage. On investigation it has been found that whenever any aged person becomes fed up with anything or is perturbed he should go immediately to some place of enjoyment, such as a club or a cinema show for diversion rather than take to alcoholic drinks or narcotic drugs like opium to forget his troubles for the time being. One must not get over-excited even in the face of extreme provocation but control one's temper as much as possible and by all means try to understand dispassionately others' point of view, although the same may be poles asunder from his.

In conclusion Dunbar thinks that as many people know these days that the span of life decreases with torments of too much anxiety and uncontrolled briddles of emotion, so even if any one cannot answer all these questions in the affirmative to score full marks, one should immediately make up one's mind to fulfil the deficiencies as much as practicable and try to control and suppress the troubles to which life has already been subjected. That is, according to him, the royal road to the well-desired longevity with happiness and enjoyment.

Dunbar's deductions on the basis of answers to his eight relevant questions offered by 300 centenarians as subjects of his investigation, definitely point to some concrete ways and means which when adopted are very likely to contribute to a good longevity with better health and performance. These points may be further clarified as follows:

(1) A happy conjugal life is always desirable and even a widower, widow or a divorced person should remarry to convert his or her monotonous single life into a blissful married one. As the saying 'स्त्रियः वाला:' goes, in India there is a belief that an old man with a young wife is more likely to live longer than others. Some of the notable and well-known personalities like Sir Winston Churchill, Lord Bertrand Russel, Fazlul Huq and others married for the last time when they were pretty old.

(2) A profession, vocation or a job must be to one's liking and there must not be clashes and conflicts with bosses, partners or associates, which are sure to cause very often worries and agonies to disturb the mental equilibrium.

(3) The family unit must be a big one, composed of well understanding members, consisting of husband, wife and at least four children (sons and daughters) with some grand-children as well.

(4) One must not be over-cautious about one's advancing years and even when any person has retired from service or normal field of activity he

should always try to follow as a principle the following lines of Longfellow,[5]

"Let us be up and doing with a heart for any fate,
Still achieving, still pursuing and learn to labour and to wait."

An inactive and inert body is the breeding ground for diseases and 'an empty mind is the devil's workshop'. Thus being busy both physically and mentally, one will not only be able to avoid these troubles but also be carefree and self-sufficient economically.

(5) Even at the fag end of one's life it is desirable that one must be associated with some religious organisation for good company and ethical discussions. That certainly does not mean that one must devote every minute of life to prayer and meditation, but must try to cultivate a religious trend of mind in order to perform all worldly duties 'with heart within and God o'er head'.

(6) All that is desired of a man nearing old age is not to think that he would be soon incapable and unfit for any good work. A firm will and determination to continue to work will keep him healthy in body and mind and make him skip over the critical period and enjoy his longevity with renewed vigour.

(7) It is not necessary that in old age one should fly away from the hubbub, turmoils and 'madding crowds' of a busy city to seek shelter to a calmer and quieter place but must remain unpurturbed by the bustles and tumults of the city-life as one's long residence makes one fully adapted to them. If compelled to leave the accustomed city-life, one is sure to feel like fish out of water, requiring further efforts to adapt to the unfamiliar situation and surroundings.

(8) With advancing years one must not avoid suitable and congenial company. Very often at this period many old friends either die or are not available near by due to illness or change of residence. So new friendships must be contracted to fill up that void as a great English writer says, "Friendship, the wine of life, like a well-stocked cellar must always be in constant repair". This applies all the more in the case of old persons who feel so lonely. So membership of a suitable club or sometimes even of a park-bench group of the same age is sure to do good.

(9) For every life there is more or less struggle for existence and so at some moments or other stress and strain are sure to crop up, which it is not possible to avoid altogether. So as in youth even in old age also one must face them complacently but manfully, keeping in mind that a perturbed mind is incapable of finding and working out the proper solution, which a placid one can easily do.

The conclusion is that too much worries and anxieties for all the time, eat into the very vitals and curtail the span of life.

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[5] Longfellow, H. W., Psalm of Life.

Besides, at the same time some essential maxims must also be regularly followed and practised as regards food, drink, sleep, activity, excercise, mental exertion, enjoyment, social contact etc. In one word, while advancing in years, "Avoid all excesses and go slow" embodied in the Indian adage "सर्वमत्यन्त गर्हितम्" one must always bear in mind as a word of caution.

Activity: It must be slow but steady. It is neither useful nor wise to whip a tired horse to win a race. By such tomfoolery, the horse is sure to stumble down sooner or later, never to get up again. By trying to over-exert unnecessarily when the body is already worn out, frail and weak one is sure to burn the candle at both the ends and exhaust life's span too soon. So to achieve the desired end the expert and cautious jockey should regulate the pace of the tired horse by a suitably constant pull on the bridle.

Food: Overfeeding is more harmful than underfeeding. For maintenance of health of the elderly the food must be easily digestible and well balanced with low calories not exceeding 2000 C for men and 1500 C for women, which will keep body weight steady without loss or gain. Low calories are required because of a decline in basal metabolic rate, reduction of body size in both bulk and weight as also body activity as a rule. Excess of fat must be avoided as it is sure to put extra and unwholesome strain on the functions of the body in general and some organs in particular, affecting life-span adversely. Reduced fat intake is also advisable in view of its slower rate of digestion tending to cause acidity, flatulence and discomfort after meals, as also impaired metabolism and deposit of cholesterol on arterial wall, responsible for atherosclerosis and hypertension. But some essential fatty acids in small amounts in the form of olive oil, saflower oil or mustard oil should be taken as they are necessary for keeping the skin healthy. Carbohydrates and delicious sweets must also be restricted in old age diet which should be selected with more stress on animal proteins such as fish, chicken (not red meat as mutton or beef), eggs, milk and milk products, especially curd or *Dahi* (yogart), cheese etc. A high protein diet intake is strongly recommended in old age as this will help to correct the negative nitrogen balance which is common with older persons. Moreover a lower protein intake or utilisation is very often sure to cause fatigue, anæmia and lowered resistance of the body. Plenty of fruits and vegetables is also advised so that a good supply of some of the vitamins and minerals will be ensured, as also constipation, if present, will be easily relieved. Small meals consisting of some of these essential items at regular intervals are to be preferred to large and voracious ones. An elderly person should do well to remember always that unnecessary overfeeding to satisfy the greed usually augers disaster to many lives in old age.

Drinks: Cold water and soft drinks like orange, lemon or tomato juice or cold *serbats* (*lassi* or *ghol*) are the ideal drinks for the aged. Ordinary beverages like tea, coffee, cocoa etc. may be taken once or twice daily but one must not be addicted to any of them. Wines, liquors etc. are

to be scrupulously avoided. Addiction to such strong drinks intoxicates the brain and is responsible for cutting short many valuable lives, young or old.

Physical Exercise: As muscle strength has already diminished, with growing age many old people are averse to any sort of exercise or activity requiring exertion on the part of the skeletal muscles. Such a sedentary life for long not only causes disuse atrophy of the muscles but also affects the skeleton (due to osteoporosis which is more common in elderly women than men of the same age group). On the other hand strenuous physical exercise is also bad for old age. By far the best exercise for an elderly person is walking for a mile or so, early in the morning before the sun-rise or just

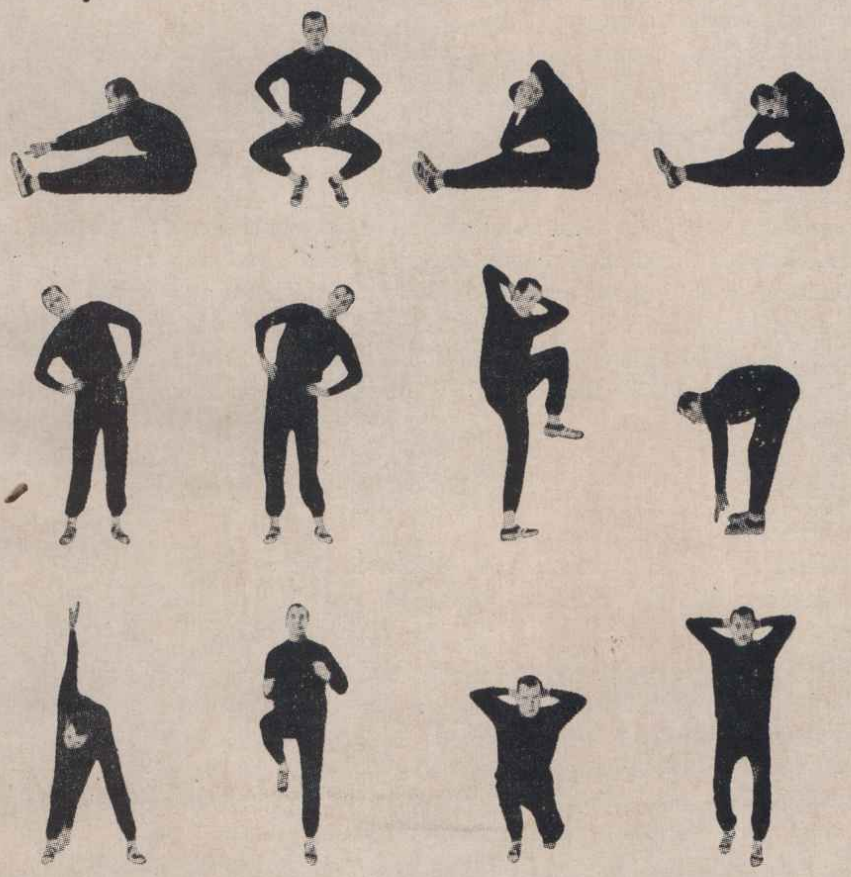

Fig. 14. Suitable indoor free-hand exercises for an aged person, which may be undertaken for a few minutes everyday with benefit.

when the sun has appeared above the horizon. Of the indoor excercises, the yogic ones (as *āshans*) are the most valuable. Some indoor free-hand exercises for 10 to 15 minutes daily (Fig. 14) are also likely to do good.

But as arthrosis of the weight-bearing joints like the hip, knee and ankle joints and cardiovascular and some pulmonary diseases, not simply

due to physiological consequences of old age, are sometimes present. They restrict the physical possibilities of the elderly to a great extent. Moreover there is complete absence of any luxury of movement pattern with poverty of movements, possibly in consequence of the attitude of disengagement. And, there is the difficulty of combining movements and engaging the pattern so that every movement is slower to commence with and performance is not up to the expected finish due to increasing rigidity of the muscles concerned.

In the western countries there are clubs where very old members are trained under the guidance of expert physiotherapists for suitable exercises to promote fitness by combating disuse atrophy of the muscles and skeleton which also are supposed to augment the motor range of all joints, stimulate circulation and respiration and at the same time also train the power of observation as well, for which Schreuder[6] suggests the following :

Under the direct supervision of such physiotherapists, the subjects overburdened with age are trained to avoid all straining and stick to some easy but useful respiratory technique. As very often most of the old people suffer from vertigo it is advisable that the exercises are done while sitting on a chair or standing with one hand at a chair for support. After a few months of warming up exercise is done with different groups of muscles for about half an hour they are allowed to enjoy themselves in ball-dancing for half an hour or so if they like and feel fit enough to participate in it. Besides facilitating and augmenting the general level of movements, they may prepare the ground for their participation in mild outdoor ventures such as walking, slow cycling etc., which are also of important social value due to psychological interactions amongst the members.

Mental Exercises: As a result of decline in sensory acuteness, may be due to diminution in the number of ganglion cells, the capacity for voluntary and involuntary adjustments in the mental sphere is also lessened exactly in the same manner as in the physical. Although many cells in the receptor system are sensitive to a wide range of stimulation so that the input has to be less selective. So old age probably accentuates selectively the individual assimilation of material for which one of the reason is that the channelling capacity of the human nervous system to cope with incoming informations is a very limited one.

Old people very often complain of a loss of memory to some extent and Gilbert[7] as a result of various tests showed that persons over sixty years of age usually lose power of retention ranging from 8-60 per cent and she is of opinion that for old people not only formation of entirely new associations is more difficult but retention of these association is also not so easy.

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[6] Schreuder, J. Th.R., *Triangle*, 1968, 88, 329-333.

[7] Gilbert, J. G., *J. Abnorm, Soc. Psychol*, 1941, 36, 73.

Although it is necessary for every man to continue learning all throughout his life, there must not be too much pressure upon the older people for assimilating new materials as there is a risk that they will fail to retain the necessary information, or what is worse, will form wrong associations based on their lifelong permanent habits but thus persist in committing the same errors again and again.

After the middle age there is slowly and gradually a decrease in the capacity for learning which is a continuous process. If one has to do it as a 'must' even in old age, it will be easier for him if he continues perseveringly to add to his former established store of informations, and it will be rather difficult where materials run counter to his established habits. In U.S.A., U.S.S.R., Great Britain and other progressive countries computers are employed to teach elderly persons more successfully by avoiding some of the major difficulties to which old men are ordinarily subjects.

Enjoyments: At intervals of work, physical or mental for old people there must be enough opportunities for diversion and recreation. These may be of the nature of indoor games like playing cards, chess, carom, billiard, table tennis etc. Even gossiping pure and simple, without slandering others may be indulged in with benefit. Occasional outing by cars or cruising for some hours or going to cinema or theatres for a show or performance as the case may be, may also do some good. But keeping late hours at night even for enjoyment's sake must be avoided altogether. Smoking a few cigarettes a day may be allowed if one badly needs that type of relaxation. Since there is diminished ability to establish libidinous relationship, fulfilment of the sexual desire just occasionaly, must not be considered as a taboo, if there is an urge for it.

Social Contacts: Nothing is more deleterious for an old man than inactivity, solitude and isolation from human contact. Less than at least one friendly visit a week must be considered as enough isolation which is sure to cause a diminution in the feeling of fitness. For such desired contacts meeting in clubs at least on alternate days, if not daily and occasional friendly visits at homes are needed, which not only promote social activities on a higher cultural level but also create interest in many speheres and stimulate mental activity. Such socio-cultural activities only can solve the problems of disengagement, inactivity and depressing solitude and afford opportunities for re-engagement for bringing back the pleasures of life.

Medical Supervision: For physical fitness and prolonging one's life-span, a periodical medical examination by the family physician is an absolute necessity. Such a regular routine check up not only provides necessary reassurance but also can offset minor ailments which if they escape detection for a long time, may turn into serious troubles not amenable to treatment. Some complaints which an old man considered as minor and not serious may sometimes tell very adversely upon his body and mind. So an early detection of a shift from the normal physiology is

urgently needed to bring it back to normality. 'A stitch in time saves nine' should always be the motto.

Drugs and Medicines: As the cause or causes of the onset of old age are not yet known definitely the ideal medicine to prevent or cure old age has yet to be discovered. But indirectly anabolic drugs such as, dianabol, durabolin etc. with protein supplements in the diet may do some good by rectifying the protein deficiency, responsible for wasting, weakness and anæmia. People in advancing years, as a rule, suffer from vitamin and mineral deficiencies, due to deficient diets, and faulty absorption and assimilation. So along with increasing easily digestible animal proteins in their diet, some preparations containing the essential vitamins and minerals may be administered daily with benefit. Vitamin A is needed to keep the eyes, skin and nervous system healthy; Vitamin B_1, to check the hypersensitiveness of the peripheral nerves and to keep functions of the brain cells normal; vitamin B-Complex, to relieve anorexia, indigestion and constipation; vitamin C, (at least 50 mg daily) to prevent scurvy, promote maturation of R. B. C., prevent fragility of bones due to collagen defect and increase resistance of the body against various infections; vitamin K, to prevent hæmorrhage and so on. Poverty, bad food-habits, defective mastication due to toothlessness or badly fitting dentures and sometimes salt-poor diet are often responsible for deficiency in animal protein, calcium, iron and vitamins, all contributing to anæmic condition more or less. So predigested proteins like Procaseional, Protinex. Aminoxyl etc. together with Nutrisan, Vimgran, Supradyn etc. as vitamin-mineral supplements, are sure to make up the deficiency and improve health of the aged.

One recently introduced drug is Gerovital (KH3 popularly known as youth pill) for oral administration which as a procaine mixture injectule was first introduced by Dr. Anna Aslan of Bucharest in 1951. After a trial on 5000 cases Dr. Fritz Wiedermann of Munich has been satisfied that it is a rejuvenating 'wonder drug' for improving heart conditions, impotency, ulcers, hypertension, Parkinson's disease and senility in persons approaching old age. In 20% of his cases there were new hair growth and stoppage of the brittleness of the nails, in 75% there was much improvement in the power of locomotion and in 80% of cases the patients got a fresh lease of strength and vitality.

Another recently favoured rejuvenating drug for injection is Siccacell (a Rhein Chemic product) prepared by Dr. Niehans from dehydrated cell extracts. This is popularly known as cellular therapy but is rather a very costly treatment within the reach of only very well-to-do people.

Hormones: When the so-called male climacteric has set in with physical weakness and somewhat mental imbalance and deterioration in libido, taking regularly methyl testosterone as linguets or propyl testosterone by injections for some time, not only revives the physical, mental and sexual

vigour but also increases the body weight and improves the general health as this hormone has also some definite anabolic effects. Such improvements, if achieved, is termed 'Rejuvenation'. But it is desirable that a course of hormonal treatment like this must be under the guidance and strict supervision of an expert physician. Hormone treatment, as a rule, is like a double-edged weapon, capable of cutting both ways. If it is a success, well and good, but if it is not, it may do immense harm.

Before the introduction of testosterone as a potent drug for this specific therapeutic use two surgical operations were advocated for the same purpose.

(1) Steinach's operation or ligation of the vas deferens. It was claimed that after such an operation there were degenerative changes with atrophy of the prostate gland, seminiferous tubules and other accessory sex apparatus with hypertrophy of the interstitial cells of the testes and thus there was a harmonious reinvigoration of physical, mental and sexual functions. But these claims have been lately conclusively disproved as vasoligation has been found to have no effect whatsoever on the sperm-producing nor on the interstitial cells of the testes, as thought before.

(2) Voronoff's operation is grafting of some other animal's (usually monkey's) healthy testes within the tunica or anywhere else in the subcutaneous tissue of the body. Although most of the tissues of the grafted organ is absorbed within a short period, the interstitial cells persist longer and elaborate the specific internal secretion which is wanting in the testes of the aged recipient. But it is uncertain to what extent such grafts are capable of secreting the internal secretion, testosterone. Moreover as now we have at our disposal the same hormone preparations, potent and effective, for sublingual or perenteral administration, there is no justification for such troublesome and costly operations of doubtful value.

On the other hand for females approaching the climacteric phase, very often there is irregular menstruation, metrorrhagia, associated with general deterioration of health and sense of well being, hot flushes and irritative temper, combined œstrogen-androgen therapy by mouth or by injections is very often useful for regularizing the monthly periods previous to the natural onset of menopause as well as bringing their physical and mental conditions to normal. Hot flushes and easy irritability due to imbalance between the sympathetic and parasympathetic functions may also be corrected by suitable drugs.

In conclusion, besides the various congenial circumstances, stressed upon by Dunbar, there are seven other pillars on which the edifice of longevity with fitness for the elderly people may be built up. They are (1) Suitable and adequate nutrition, (2) Plenty of cold soft drinks, (3) Proper and adequate physical exercise, (4) Continuation of suitable and healthy mental activities, (5) Sufficient and enjoyable social contacts, (6) Regular supervision and proper medical check up from time to time and

lastly (7) Vitamin-mineral and hormone supplements according to necesssity.

There cannot be any universal recipe for all the old people. One must not forget that for the onset of old age sooner or later heredity also counts and it is not always that old age depends upon the number of years one has lived, but in some cases at least due to heredity or other factors physical appearance is rather deceptive inspite of increasing years, proving thereby the truth of the adage "one is not as old as one looks but as old as one feels".